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DISSERTATION

Scientometric Study of Patent Literature in MEDLINE & SCI

Zur Erlangung der Doktorwürde

Philosophische Fakultät I

Mohammad Hossein Biglu

(aus dem Iran)

Dekan der Philosophischen Fakultät I Prof. Dr. Michael Borgolte

Gutachter: 1. Prof. Dr. Walther Umstätter

2. Prof. Dr. Robert Funk

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Zusammenfassung

Die Studie wird in fünf Teile unterteilt:

Das erste Kapitel beschäftigt sich mit Patentanmeldungen und geförderten Patenten, die vom US-Patentamt [*Patent and Trademark Office (USPTO*)] vergeben werden, Patentanwendungen von der Weltorganisation für geistiges Eigentum [*World Intellectual property Organization (WIPO*)], und dem Europäischen Patentamt [*European Patent Office (EPO*)].

Alle USPTO Patentdaten stammen vom Amt für elektronische Informationsprodukte / Patenttechnologie Überwachungsdivision. Die WIPO and EPO Patentdaten wurden jeweils aus den Websites der Weltorganisation für geistiges Eigentum und dem Europäischen Patentamt entnommen.

In diesem Kapitel wird die Korrelation zwischen dem Bruttoinlandsprodukt (BIP) und der länderspezifischen Patentanzahl analysiert. Die allgemeine Entwicklung der US-Patentanwendungen und geförderten Patente wird über 40 Jahre (1965-2005) präsentiert. Die Veränderungen über die Zeit bezüglich der Patentrate und der Anzahl von geförderten Patenten wird ausgeführt.

Das zweite Kapitel gibt einen Überblick über die existierende Literatur über Patente in MEDLINE (sowohl in PubMed als auch in ERL). In diesem Kapitel wird eine szientometrische Analyse durchgeführt, damit die Entwicklung der Patentliteratur in MEDLINE über den Zeitraum von 1965 bis 2005 quantitativ gemessen werden kann. Die Auswahl der Sprachen, die Veröffentlichungsform (Zeitschriften usw.) und die Herkunft der veröffentlichten Dokumente werden präsentiert.

Das dritte Kapitel befasst sich mit der Literatur über Patente in dem wissenschaftlichen Zitierungsindex [*Science Citation Index (SCI*)]. In diesem Kapitel werden alle Dokumente, die vom SCI über den Zeitraum 1965 bis 2005 als "Patent"-Gegenstände Bereich (Tag/fields) indexiert wurden, unter die Lupe genommen. Es werden Informationen über die Veröffentlichungsform, die Patentherkunft, die Zitierungsfrequenz, den Dokumententyp, die Veröffentlichungssprache, die Zeitschriftenverteilung, und die am meisten zitierten Autoren der Literatur über Patente ermittelt.

Das vierte Kapitel analysiert die Patentdokumente, die im wissenschaftlichen Zitierungsindex (SCI) zitiert werden, und illustriert die durchschnittliche Anzahl von Nennungen pro wissenschaftlicher Veröffentlichung für Patente zitierende Dokumente. Diese Tendenz wird anschließend mit der allgemeinen Entwicklung von veröffentlichten Dokumenten verglichen.

Patentnennungen werden durch die Anzahl von Patenten identifiziert, die in der Suchmaschine anstelle des Autorennamen im Referenzbereich erscheinen. Die Halbwertzeit von zitierten Patentdokumenten und allgemeinen wissenschaftlichen Dokumenten werden definiert. Außerdem wird die Entwicklung des Bedeutungswerts für die Anzahl von zitierten Verweisen pro Dokument im SCI illustriert.

Das fünfte Kapitel analysiert die Nennungen pro Zeitschrift im SCI über den Zeitraum 1970-2005. In diesem Hinblick wurde eine Gesamtzahl von 10,000 Dokumenten pro Jahr ausgesucht sowie der Bedeutungswert von Nennungen pro Zeitschrift berechnet.

Der Impact-Factor (IF) von allen Zeitschriften, die im Journal Citation Reports (JCR) über die Jahre 1999 bis 2005 registriert wurden, wurde extrahiert und der Bedeutungswert von ihrem IF wurde berechnet, damit dieser dann mit der allgemeinen Referenzentwicklung pro Zeitschrift in dem SCI verglichen werden kann.

Alle Daten entnommen aus den jährlichen Volumen des CD-Verlags des wissenschaftlichen Zitierungsindexes (SCI) und der wissenschaftlichen Website (Web of Science) des Instituts für Wissenschaftliche Information (ISI), die Zeitschriftzitierung und die Selbstzitierung Daten dem JCR entnommen, die Selbstzitierungsrate und selbst zitierte Rate berechnet durch die JCR-Methode (die Selbstzitierungsrate in dem Prozentsatz der selbst zitierten Zeitschriften (*journal self-citations*) durch die Gesamtzahl der Zitierungen (Referenzen), die über einen gewissen Zeitraum in der Zeitschrift erschienen sind. Die Selbstzitierungsrate ist der Prozentsatz der selbst zitierten Zeitschriften *(journal self-citations)* durch die Gesamtzahl der Zitierungen einer Zeitschrift während eines bestimmten Zeitraums).

Die Analyse der Daten ergab:

Die USA sind das führende Land bezüglich der Erstellung und der Zulassung von Patenten, gleichermaßen gefolgt von Japan und Deutschland.

Es besteht eine lineare Verbindung mit dem Verbindungskoeffizienten $R > 0,96$ zwischen dem BIP und Patentanwendungen von Ländern, wenn deren Patentanwendungen eine jährliche Anzahl von 500 überschreiten.

Die Halbwertszeit der Zitierung von Patenten beträgt seit 1994 konstant 8,1 Jahre. Das ist eine 41% längere Zitierungsrate gegenüber den allgemeinen wissenschaftlichen Dokumenten im

SCI, die seit dieser Zeit stetig anwächst und zwischen 1994 und 1999 einen Mittelwert von 5,73 hat.

Es gibt eine lineare Korrelation zwischen der Zahl von Literaturhinweisen (Referenzen) in einem Journal, wie sie im SCI erfasst sind, und der Wahrscheinlichkeit zitiert zu werden. Dieses Verhältnis beträgt 1,5 und besagt, dass auf 2 Referenzen 3 Zitationen des eigenen Journals kommen, von denen etwa 12 % Selbstzitationen sind

Die Anzahl der Literaturhinweise (Referenzen) pro Veröffentlichung zwischen 1970 und 2005 im SCI ist ständig angestiegen. Der hauptsächliche Wert der Referenz pro Veröffentlichung stieg von 8,40 im Jahr 1970 auf 34,63 im Jahr 2005, eine Steigerung auf mehr als das Vierfache.

Die Selbstzitation von Zeitschriften bei einer steigenden Zahl von Verweisen beeinflusst die Steigerung des Impact Factor im SCI. Die Leitartikelpolitik der Sprachen wurde in der MEDLINE und im SCI geändert. Das Hauptaugenmerk dieser Datenbanken liegt auf englischsprachigen Veröffentlichungen.

Schlagwörter:

Medizin, MEDLINE, MeSH, Patent, Geförderte Patent, Patentanmeldung, Patentliteratur, Wissenschaftlichen Ertrag, Scientometrics, USPTO, WIPO, EPO, SCI, , BIP, FuE, Zitierung, Selbstzitierungsrate, Halbwertzeit.

Abstract

This study is divided into five sections.

The first section consists of patent applications and granted patents issued by the United States Patent and Trademark Office (USPTO), patent applications in the World Intellectual property Organisation (WIPO), and European Patent Office (EPO).

All USPTO patents data were extracted from the office of electronic information products / patent technology monitoring division. WIPO and EPO patents data were extracted from the websites of World's Intellectual Organisation and European Patent Office respectively.

In this section the relationship between the Gross Domestic Product (GDP) and country's patent quantity is analysed. The main trend of U.S. patenting applications and granted patents is presented over 40 years (1965-2005). The changes over time in the rate of patenting and the number of granted patents are exhibited.

The second section analysis the patent literature in MEDLINE. In this section a scientometric analysis is performed to assess the quantitative trend of patent literature in MEDLINE throughout 1965-2005. The kind of languages, publication type, journals, and the origin of published documents are presented.

The third section analysis the patent literature in the Science Citation Index. In this section all documents indexed as a topic of "patents" (in the Field of Tags) in the SCI throughout 1965-2005 are analysed. The publication pattern concerning, origin of patents, citation frequency, document types, the language of publication, distribution of journals, and the most frequently patent citing authors are performed.

The fourth section analysis the citations to the patent documents indexed in the Science Citation Index, and illustrate the average number of cited references per paper for patent citing documents and comparing them with the general scientific documents.

References to patents are identified through patent numbers that appear instead of the first authors name in the reference search of the cited author / field. The half-life of citations to the patent documents and general scientific documents are defined. Furthermore the growth of the mean value for the number of cited references per documents in the SCI is illustrated.

The fifth section analysis the references per paper in the SCI through 1970-2005. To achieve this aim a total number of 10,000 records for each year of under study were randomly chosen and the mean value of references per paper was calculated.

The Impact Factor (IF) of all journals indexed in the Journal Citation Reports (JCR) throughout 1999-2005 was extracted and the mean value of their IF was calculated in order to compare with the trend of references per paper in the SCI. All data extracted from the annual volumes of the CD-Edition of Science Citation Index (SCI) and the web of science of the Institute for Scientific Information (ISI). The journal citation and self-citation data extracted from the JCR. The self-citing rate and self-cited rate calculated based on the JCR method (The self-citing rate is the percentage of journal self-citations divided by the total number of citations (references) that appeared in the journal during a given period of time. The self-cited rate is the percentage of journal self-citations divided by the total number of citations the journal received during a given period of time).

The Analyses of data showed:

The USA is the leading country filing and granting patents followed by Japan and Germany respectively.

The relationship between patent applications and gross domestic product (GDP) of the different countries, with applications greater than 500 patents annually, is a linear relationship with a correlation coefficient of $R > 0.96$, in contrast to the relation of patent applications to the population size $R = 0.42$ (power law).

The half-life of citations to the patent-documents with 8.1 years is 41% higher than the half-life of citations to the general scientific documents in the SCI.

There is a linear correlation between the number of references in a journal and the probability to be cited by other journals in the SCI, by a factor of 1.5 [citing/cited]. It means that every 2 references in a journal cause the journal to receive 3 citations

The number of references per paper from 1970 to 2005 has steadily increased. The mean value of references per paper increased from 8.40 in 1970 to 34.63 in 2005, an increase of more than 4 times.

The rough constant percentage of self-citation of journals and the growing increase of references per paper led to the absolute growing number of self-citations and to the increase of the Impact Factor of the citing journals in the SCI. The number of references per paper in the SCI shows a growing of 412% from 1970 to 2005.

The editorial policy of languages is being changed in MEDLINE and in the SCI. The consideration of policy makers in these databases have been focused on the literature in

English. Analysis of data predicted that the percentage of publications in English in MEDLINE will reach to the saturation value at 97% in 2030.

There was a tendency in the last decades towards collaboration in scientific publishing with American authors that can be observed in the SCI with authors from different countries.

Keywords:

Medicine, MEDLINE, MeSH, Patent, Utility patent, Design patent, plant patent, Patent literature, Trademark, copyright, Scientometrics, Citation, self-citation, self-citing, self-cited, citation classic, Impact Factor, half-life, GDP, R&D.

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Dedication

- To the soul of my venerated father Nosrat Biglu, may his dear soul rest in peace.
- To the soul of my teacher, my spiritual coach and my beloved brother Abdollah Biglu.
- To my mother Leili Shami who taught me the meaning of love and faith.
- To my daughter Sahar (Setareh) for very lovely encouragement and patience over these years.

List of abbreviations

A&HSCI	Arts and Humanities Citation Index
AB	Abstract
AD	Affiliation
AID	Article Identifier
AU	Author
BMC	BioMed Central
CI	Copyright Information
CN	Corporate Author Comments/Corrections
DA	Date Created
DCOM	Date Completed
DEP	Date of Electronic Publication
DP	Date of Publication
EDAT	Entrez Date
FAU	Full Author
FPS	Full Personal Name as Subject
FUTON	Full Text on the Net
GN	General Note
GR	Grant Number
GS	Gene Symbol
IF	Impact-Factor
IP	Issue
IR FIR	Investigator Name and Full Investigator Name
IRAD	Investigator Affiliation

IS	ISSN
ISI	Institute for Scientific Information in Philadelphia, USA
JAD	Journal Authors Distribution
JCR	Journal Citation Reports
JID	NLM Unique ID
JT	Journal Title
LA	Language
LR	Date Last Revised
MH	MeSH Terms
MHDA	MeSH Date
NAA	No Abstract Available
NM	Substance Name
OAB	Other Abstract
OAJ	Open Access Journals
OCI	Other Copyright Information
OID	Other ID
OT	Other Term
OTO	Other Term Owner
OWN	Owner
PG	Pagination
PHST	Publication History Status
PL	Place of Publication
PloS	Public Library of Science
PMID	PubMedUnique Identifier

PS	Personal Name as Subject
PST	Publication Status
PT	Publication Type
PUBM	Publishing Model
RF	Number of References
RN	Registry Number/EC Number
SB	Subset
SCI	Science Citation Index
SFM	Space Flight Mission
SI	Secondary Source ID
SO	Source
SSCI	Social Science Citation Index
STAT	Status
TA	Journal Title Abbreviation
TI	Title
TT	Transliterated Title
VI	Volume

Preface

The experience of teaching at the University of Medical Science over the last few years led to my study of scientific output in medicine. After consultation with my supervisor Prof. Dr. Umstätter, we decided to study the scientific output in the form of patent literature in the medical fields, so we selected the database MEDLINE, which is one of the most famous and world-wide used database in medicine.

The initial result of study showed that the most majority of patent literature in MEDLINE was in English. There seemed to be a relationship between the wealth of countries and the amount of scientific output in the countries. Apparently this relationship excluded the oil producers' countries such as Iran, Iraq, Qatar, and Saudi Arabia among countries with high rate of GDP.

It seemed necessary to explore the trend of publications languages in MEDLINE, and to determine the influence of wealth in the countries on the scientific output.

To make comprehensive the domain of study, and to illustrate the trend of citations to the patent documents in the Scientific publications, we decided besides the MEDLINE to study the database of "Web of Science" which consisted of Science Citation Index, Social Citation Index, and Art & Humanities Citation Index and provides access to current and retrospective multidisciplinary information from approximately 8,700 of the most prestigious, high impact research journals in the world.

To explore the relationship between the number of patent applications and the GDP of countries, the three famous patent organisations- United State Patent and Trademark Office (USPTO), World Intellectual Patent Organisation (WIPO), and European Patent Office (EPO) were selected.

The number of patent applications in these three patent organisations, versus the GDP of countries, definitely illustrates the influence of countries GDP on the amount of scientific output in the form of patent applications. On the other hand, the study of publications language in MEDLINE and in the Science Citation Index (more comprehensively in the Web of Science) would show the policy of these databases in selecting publications languages from different countries entering data into these databases.

The databank of Journal Citation Reports (JCR) was selected to explore the influence of growing number of references per paper into Impact Factor (IF) of journals in the JCR.

We investigated the scientific activity of countries versus GDP rather than the R&D expenditure. The reason is that data about R&D expenditures deviates highly in different sources. At first because there are different kinds of R&D expenditures (money from foundations, the government, the industry, military institutions, the universities, etc.) and at second because the different types of scholarship, that makes the definition of R&D expenditures ambiguous.

1 Introduction:

The increase of publications, libraries, databases, and other networked computerized resources has changed our society. The information technology by providing information and sharing knowledge experiences has turned our world into a global village- a common and easy accessible place where many sources are located. Information technology innovations have revolutionized information delivery, affecting the production, transformation and consumption of our social life and behavior, even the political institution and the role of citizen with them. The new information technology such as email, online conference, electronic commerce, online information demand, web-powered information diffusion and interest aggregation have lead to a more informed, engaged and influential mass public.

"The internet provides information to everyone as soon as it is posted to the Web."[1] In fact, the emergence of the internet has turned our world into an open network. Globalization has provided a more sophisticated collaboration and relationship between scientists and researchers as well as facilitating their access to information retrieval more thoroughly, effectively and attractively all over the world so that "today we are evolving rapidly into knowledge-based society, a shift in culture and technology as profound as the shift that took place a century ago when our agrarian societies evolved into Industrial nations."[2]

"The development of online electronic versions of journals has revolutionised scientists' access to the literature. Over 90% of STM (Scientific, Technical and Medical) journals are now online, and in many cases their publishers have retrospectively digitised earlier hard copy material back to the first volumes. More content is available to more users than at any time in history while the cost of use of each article is falling to well below one euro. The industry has made this possible through the application of sustainable business models and the collective investment of hundreds of millions of euros in electronic developments."[3]

According to the report of Nielsen//NetRatings, a global leader in internet media and market research, on October 13th 2005, the education reference web sites attracted nearly 46.4 million

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[1] Feldman, Maryann P. (2006). The Internet Revolution and the Geography of Innovation. Retrieved December 6, 2006 from http://www.cs.jhu.edu/~mfeldman/feldman%20ISSJ%20Submission.pdf

[2] Duderstadt, James. (2006). Higher Education in the 21st Century: Global Challenges, Responsibilities, and Opportunities. Conducted at the international seminar: Beyond the University: Shifting Demographics in Higher Education, Salzburg, Austria.

[3] Scientific publishing in transition: an overview of current developments. Retrieved September 2006 from www.alpsp.org.

web users. This marks a 22 percent jump in this category from the previous year, which can be attributed mainly to the triple-digit growth of Wikipedia and Yahoo! Education.[4] The positive influences of such opportunities appear in scholarly works, scientific collaborations and eventually emerging innovations and publishing their scientific output in different forms. “The number of scientific articles catalogued in the internationally recognized peer-reviewed set of Science and Engineering (S&E) journals covered by the *Science Citation Index (SCI)* and *Social Sciences Citation Index (SSCI)* grew from approximately 466,000 in 1988 to nearly 700,000 in 2003, an increase of 50%.”[5] ”The number of periodical peer-reviewed scientific publications is approximately estimated to exceed 16,000 worldwide; nearly 1.4 million articles are published every year.”[6]

“More than 400,000 new research articles listed each year in PubMed alone. The power of post-genomic research technologies and increases in biomedical research funding suggest that we can expect the number of articles to continue to expand at an overwhelming rate. The sheer scale of the scientific literature poses a formidable challenge to research scientists in their attempt to locate published results that are relevant to their research interests.”[7]

“There are about 23,000 scholarly journals in the world, collectively publishing 1.4 million articles a year. The number of articles published each year and the number of journals have both grown steadily for over two centuries, by about 3% and 3.5% per year respectively. The reason is the equally persistent growth in the number of researchers, which has also grown at about 3% per year and now stands at around 5.5 million.”[8]

These are indicators for science and technology development in countries which may be used as statistics that measure quantifiable aspects of the creation, dissemination and application of science and technology. As indicators they should help to describe the science and technology

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[4] Nielsen//NetRatings. Retrieved October 13, 2005 from http://www.nielsen-netratings.com/pr/pr_051013.pdf

[5] Science and Engineering Indicators. Retrieved June 14, 2006 from http://www.nsf.gov/statistics/seind06/c5/c5s3.htm.

[6] Mabe, Michael and Amin Mayur (2001). Growth dynamics of scholarly and scientific journals. Scientometrics Vol. 51, No.1, p.147-162.

[7] Cockerill, Matthew (2003). Analysing the scientific literature in its online context. Retrieved September 2, 2006 from http://www.mrc.ac.za/ikmd/openaccess.pdf#search=%22scientific%20literature%20is%20growing%20%22

[8] Scientific publishing in transition: an overview of current developments. Retrieved September 2, 2006 from www.alpsp.org

system, enabling better understanding of its structure, of the impact of policies and programs on it, and of the impact of science and technology on society and the economy.

“Accurate recognition of the trends of scientific research is not only necessary to enable researchers to plan research projects, but is also useful for research organisations such as universities, faculties or departments, academic societies and organizations related to science policy that wish to improve research systems and effectively promote research activities.”[9]

One of the most reliable ways to track science and technology activities is the study of scientific literature (Journal Articles, News, Review, Comment, Letter, Editorial, Newspaper Article, etc.), co-authorship, patents, citations, co-citations. Examining scientific literature underpins analysis of the scientific community and its structure in a given society, as well the motivations and networks of researchers.

“The scientific literature is a mechanism for the dissemination and archiving of research, but it has been also an object of study in itself. Analysing such data provides information on the scientific orientation and dynamism of a country as well as its participation in science and technology worldwide. In other words, it provides information on its impact on both the national and international community.”[10]

“A crucial dimension in the process of developing capacity relates to the adoption of policy measures regulating intellectual property rights and their related patenting and licensing activities.”[11]

With the arrival of improved quality data and easier access to it, the analysing of patent activities and patent citation analysis has become an important topic that has been receiving an increasing level of attention in recent years. [12]

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[9] A Study of International Comparison of the Number of Scientific Papers. Retrieved October 24, 2006 from http://www.nii.ac.jp/ENEWS/NL14/1412.html.

[10] Analysing the scientific literature in its online context. Retrieved December 6, 2006 from http://www.nature.com/nature/focus/accessdebate/18.html.

[11] Looy, Van Bart; Ranga, Marina; Callaert, Julie; Debackere, Koenraad and Zimmermann, Edwin (2004). Combining Entrepreneurial and Scientific Performance in Academic: Towards a Compounded and Reciprocal Matthew-Effect?. Research Policy, Vol. 33, p.425-441. Retrieved October 23, 2006 from http://www.sciencedirect.com/science?_ob=MImg&_imagekey=B6V77-4C52R24-2-X&_cdi=5835&_user=964000&_orig=na&_coverDate=04%2F30%2F2004&_sk=999669996&view=c&_rdoc=1&wchp=dGLbVzb-zSkzV&md5=524b92dbadbe72019b58a2ef1f77e1a1&ie=/sdarticle.pdf

“As patent data become more available in machine-readable form, an increasing number of researchers have begun to use measures based on patents and their citations as indicators of technological output and information flow.”[13]

“The analysis of patent information is considered to be one of the most established, directly available and historically reliable methods of quantifying the output of a science and technology system.”[14]

“The number of patent applications filed by domestic inventors is one metric of the innovation activity within a country. There is a strong correlation between innovation activity and the economic well being of a country. The World Bank data showed that in high-income countries, there was one (1) domestic patent filing for every 1,300 people (in 1997); in middle-income countries, one (1) patent application for every 20,000 people; and in low-income countries, (one) 1 patent application was filed for every 144,000 people. There are many related reasons for this discrepancy. One of those reasons is that there are five times as many scientists and technologists in research and development activities in high-income countries than medium-income countries. Low-income countries are even further disadvantaged. This factor along with capital-formation differences between these countries leads to the uneven distribution of economic growth throughout the world.”[15]

“The patent law in the United States and other countries provides the inventor with protection of his or her invention for a period of twenty [20] years (eighteen [18] years in the U.S.) in return to making the details of the invention public. The procedure by which the government grants this protection is called “granting a patent”. The word “patent” refers to the protection. This protection consists of giving exclusive control of the invention to the inventor and not allowing anyone else to use it without the permission of the inventor. If someone else uses it without permission (“infringes on the patent”), the inventor can sue and recover damages.

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[12] Michel, Jacques and Bettels, Bernd (2002). Patent citation analysis a closer look at the basic input data from patent search reports. Scientometrics, Vol. 51, No. 1, p. 185–201.

[13] Hall, Hughes Bronwyn; Jaffe, Adam and Trajtenberg Manuel (2000). Market Value and Patent Citations: A First Look. Retrieved December 27, 2006 from http://ideas.repec.org/p/nbr/nberwo/7741.html.

[14] Soete, L. G. and Wyatt, Sally M. E. (1983). The use of foreign patenting as an internationally comparable science and technology output indicator. Scientometrics, Vol. 5, No. 1, p.31-54.

[15] Przybylowicz, Edwin P. (2003). A challenge to the World’s Scientists. Retrieved July 5, 2007 from http://www.iupac.org/publications/ci/2003/2503/oc.html

The inventor can also discontinue any future use of the patent unless it is done on his or her terms. Anyone who wishes to use it may have to pay the inventor a fee called “royalty” for the use of the patent. This process is usually called “licensing” the patent, since the inventor gives a “license” to use the patent. In most countries this protection starts from the date the patent was filed. However, in the United States this protection starts from the time the invention is made-up as long as the inventor filed for a patent within one year. The actual owner of the patent is not always the inventor but can be anyone else the inventor gave or has to give by law ownership of the patent. The actual owner is called the “assignee” of the patent, and the process of giving ownership is called “assignment”. Thus, the patent may cover an invention made by person A, who asks the patent to be “assigned” to person B who is called the “assignee”. The assignee is considered by law in place of the inventor and may do anything the inventor and eligible including suing, licensing, charging royalties and the like. In order for the patent to be granted the invention has to be new. Anything that was invented or existed before the invention was invented is called “prior art”. The filer of the patent has to demonstrate that the invention provided something new that is not found in prior art. If it can be proven that the invention existed beforehand, the patent (if granted) can be invalidated.

The patent application itself is divided into several sections. The first section is called the “claims section”, it sets out several claims that the inventor claims are new and should be protected by a patent. This section is the main section of the patent application describing what exactly is protected under the patent. The next section is called the “background section” it describes why the prior art was deficient and how the invention overcomes those deficiencies. It then explains in detail what the claims in the previous section are. The next section describes the “preferred embodiment” of the patent.”[16]

“Patents have long been recognized as a very rich and potentially fruitful source of data for the study of innovation and technical change.”[17] Indeed, there are numerous advantages to the use of patent data.

“1. Each patent contains highly detailed information on the innovation itself, the technological area to which it belongs, the inventors (e.g. their geographical location), the assignee, etc.

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[16] Shafranovich, Yakov (2001). A Brief Study of Patent and Its Impact on Universal Shopping Cart and Product Comparison Technologies Used on the Internet (2001) CIO of Solid Matrix Technologies, Inc. Retrieved December 5, 2006 from http://www.shaftek.org/publications/patent.pdf

[17] Hall, Hughes Bronwyn; Jaffe, Adam B. and Trajtenberg Manuel, (2001), The Neber Patent Citation Data file. Retrieved June 14, 2006 from http://papers.nber.org/papers/w8498.pdf.

Moreover, patents have very wide coverage (in terms of fields, types of inventors, etc.). In the course of the last three decades U.S. patents increasingly reflect not only inventive activity in the U. S. itself, but also around the world. “The percentage of U. S. patents awarded to foreign inventors has risen from about 20% in the early sixties, to about 45% in the late1990s.”

“2. There are a large number of patents, each of which constitutes a highly detailed observation. Thus the wealth of data that is available for research is huge.”

“3. Patents have been granted in the U.S. continuously from the end of the 18th century”.[18]

4. Patent data include two kinds of references: Those provided by the inventor in the text of the application and disclosure and those provided by the patent examiner at the end of the patent. Those provided by the examiner constitute a large majority of the references.

“Patents indicate a transfer of knowledge into industrial innovations a transformation into something of commercial and social value; for this reason they constitute an indicator of the tangible benefits of an intellectual and economic investment.”[19]

“There are also serious limitations to the use of patent data, the most obvious one being the fact that not all inventions are patented.”[20]

There are some methods for the measurement of patent and research activities, among them Scientometrics, which has earned its place as an important tool in evaluating research activities and scientific output by counting the number of papers and the impact of papers on scientific disciplines, by counting the number of citations, patents, etc. Its mechanism is based on the enumeration and statistical analysis of scientific output in the form of articles, publications, citations, patents and other indicators. The purpose of Scientometrics is to measure the output of scientific and technological research through data not only from scientific literature but from patents as well.

“The idea of examining literature goes back to the beginning of the twentieth-century. In 1917, Cole and Elaes published a statistical analysis of the history of comparative anatomy. They were the first to use published literature to build up a quantitative picture of progress in

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[18] United State Patent and Trademark Office. Retrieved November 15, 2006 from http://www.uspto.gov.

[19] Okubo, Yoshiko (2006). Bibliometric Indicators and Analysis of Research Systems:Methods and Examples. Retrieved December 22, 2006 from http://ideas.repec.org/p/oec/stiaaa/1997-1-en.html

[20] Hall, Hughes Bronwyn; Jaffe, Adam B. and Trajtenberg Manuel (2001). The Neber Patent Citation Data file. Retrieved November 15, 2006 from http://elsa.berkeley.edu/~bhhall/pat/NBERpatdata.pdf

the field of research."[21]"Further work was carried out by Hulme in 1923, this time using patents. By correlating patents and scientific literature in order to measure social progress in Britain, Hulme pioneered a modern methodology for the history of science."[22]

1.1 Aims:

This study endeavours to analyse:

1. All patent literature[23]indexed as a main heading of "Patents" limited to the field of MeSH Major Descriptor from two servers of MEDLINE (PubMed[24] and ERL[25]) through 1965-2005 to show the trend of patent literature in this widely used database.

2. All patent application in USPTO, WIPO and EPO through 2002-2005 to explore the relationship between GDP and innovation activities in the countries.

3. All citations to the Patent documents (cited-patents) in the Science Citation Index (SCI) for a period of 5 years 1995 – 1999 in order to map the growth of citations to the patent documents during these years as well as determining the half-life of citations to the patent documents and comparing their trend with the half-life of citations to the general scientific literature in the SCI.

4. The database of United State Patent and Trademark Office is used to extract patent applications and granted patents by countries to present the filing and grating patents by countries over the last 40 years and to compare their trend with the patent literature in MEDLINE and in the SCI.

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[21] Cole, J. and Eales, N.B. (1917). The history of Comparative Anatomy: A statistical Analysis of the Literature. Science progress,Vol.11, No. 4, p. 578-596.

[22] Hulme, E.W. (1923). Statistical bibliography in Relation to the Growth of Modern civilization, Grafton. London.

[23] Scientific articles/journals, book, or indeed any dated written disclosure or publication which has been made available to the public about patent.

[24] PubMed is a service of the U.S. National Library of Medicine that includes over 16 million citations from MEDLINE and other life science journals for biomedical articles back to the 1950s. PubMed includes links to full text articles and other related resources. http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?DB=PubMed .

[25] ERL (Electronic Reference Library) is Ovid's versatile TCP/IP networking solution available on the SilverPlatter platform. Featuring flexible client/server technology, and choice of platform (Windows NT/2000 or Solaris), ERL has been the preferred networking solution for thousands of academic institutions worldwide.

5. All journals Impact Factor (IF) indexed in the Journal Citation Report (JCR) throughout 1999-2005 to show the growth of journals IF as well as the correlation between IF and self-citation of journals in the JCR.

5. All publications in English, French, German and Russian in MEDLINE through 1965-2005, in order to determine the trend of publications in English, French, German and Russian in MEDLINE.

6. All publications in English, French and German in the Science Citation Index through 1965-2005, in order to determine the trend of publications in English, French and German in the SCI.

1.2 Major goals of the study:

The major goals of this study are to explore the relationship between the GDP and innovation activities in the countries, and to investigate the trend of patent literature in MEDLINE and in the Science Citation Index (SCI) during the last 40 years (1965 – 2005). The reason for choosing the year 1965 as the starting point for this study is that, this is the first year MEDLINE has indexed patent literature in its database. The database of the United States Patent and Trademark Office is used to extract all patents application and granted patents in order to compare with patent literature extracted from MEDLINE and The SCI to illustrate the difference among them.

1.3 General purpose of the Study:

The general purpose of the study is:

1. to illustrate the trend of patent literature in MEDLINE during the years 1965-2005.

2. to illustrate the productivity within different areas of medical science following MEDLINE during the years 1965-2005.

3. to determine the most productive area amongst the fields following MEDLINE.

4. to determine which country achieved the majority of patent literature.

5. to determine most prolific periodicals that published most articles about patent literature during the period of study.

6. to determine most prolific authors (Senior authors) throughout the period of study.

7. to determine the majority of patent literature languages.

8. to determine the majority format of patent literature (in which format of has been Published (journal articles, news, review, comment, letter, editorial, newspaper article and etc) have been published.

9. to illustrate the trend of citations to the patent documents (cited-patents) in the Science Citation Index throughout 1965-2005.

10. to determine the trend of cited references per paper in the Science Citation Index (SCI).

11. to determine the growth of journals Impact Factor (IF) in the Journal Citation Report (JCR) and the correlation between self-citation and IF of journals in the SCI.

The results of this study will be helpful in illustrating the trend of inventive and innovative activities in the countries and their reflection in the world's largest Medical Library (MEDLINE), and in the Science Citation Index (SCI) during the period of study.

1.4 Databases:

There are two different types of Scientometric data that can be used for analysis of the output of national and international R&D efforts, patents and the literature about patents. The later one can be appeared in the form of papers, notes, summaries, letters to the editors, reports, notices, discussions, etc. about patents.

In this study the author is interested in analysing of patent applications, patent literature, cited references per paper, and the languages of scientific publications. To achieve the aims; some set of databases are used as follow:

1.4.1 The United States Patent and Trademark Office (PTO or USPTO):

"USPTO is the only official web site of the United States Patent and Trademark Office. It offers the most complete bibliographical information about US patents, including abstracts and the full texts of all claims and all citations for other patents and for the science and technology literature. The patents are indexed using IPC-codes (International Patent classification). Currently, 644 different ICP-codes are defined on a 4 digit level. The USPTO is an agency in the United States Department of Commerce that provides patent and trademark protection to inventors and businesses for their inventions and corporate and products identification. "The PTO is currently based in Alexandria, Virginia, after a recent move from the Crystal City area of Arlington, Virginia. Since 1991 the office has been fully funded by fees charged for processing patents and trademarks. The current head of the

USPTO is Under Secretary of Commerce for Intellectual Property Jon W. Dudas, a position to which he was nominated by President George W. Bush in March 2004 and appointed July 30, 2004."[26]

"The mission of the PTO is to promote "industrial and technological progress in the United States and strengthen the national economy" by:

administering the laws relating to patents and trademarks;

advising the Secretary of Commerce, the President of the United States, and the administration on patent, trademark, and copyright protection; and

providing advice on the trade-related aspects of intellectual property.

Each year, Congress "diverts" about 10% of the fees that the USPTO has collected into the general treasury of the United States. Effectively this takes money collected from the patent system to use for the general budget. This fee diversion is generally opposed by patent practitioners (e.g patent attorneys and patent agents), inventors, and the USPTO. These stakeholders would rather use the funds to improve the patent office and patent system, such as implementing the USPTO's 21st Century Strategic Plan."[27]

"Each year, the PTO issues thousands of patents to companies and individuals all around the world. As of March 2006, the PTO has issued over seven million patents."[28]

"The X-Patents (the first 10,000 issued between 1790 and 1836) were destroyed by a fire; less than 3,000 of those have been recovered and re-issued with numbers ending in "X" to distinguish them from those issued after the fire.

On July 31, 1790, the USPTO awarded its first patent to Samuel Hopkins for an improvement "in the making Pot ash and Pearl ash by a new Apparatus and Process." This patent was signed by then president George Washington.

The PTO only allows certain qualified persons to practice before the PTO, which includes the filing of patent applications on behalf of inventors, the prosecuting patent applications on behalf of inventors, and participating in administrative appeals and other proceedings before the PTO examiners and boards. The PTO sets its own standards for who may practice and

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[26] Trademark Office. Retrieved August 24, 2006 from http://www.lycos.com/info/trademark--trademark-office.html.

[27] United State Patent and trademark office. Retrieved June 12, 2006 from http://www.uspto.gov/web/offices/com/strat21/

[28]Wikipedia. Retrieved March 12, 2006 from http://en.wikipedia.org/wiki/March_2006

requires that any person who practices become registered. An USPTO-registered non-attorney professional is called a patent agent and an USPTO-registered attorney is called a patent attorney.

In order to become registered to practice for the USPTO an applicant must demonstrate certain scientific and technical competencies and pass a difficult USPTO-administered patent bar exam called the USPTO Registration Examination. This bar exam covers the voluminous regulations and procedures that govern USPTO practice. The registration process is managed by the USPTO's Office of Enrollment & Discipline (OED)."[29]

"An individual inventor may file and prosecute a patent application by themselves. This is called filing a patent pro se.[30] The inventor does not need to be represented by a registered patent attorney or patent agent. Therefore if a patent examiner realizes that an inventor filing a pro se application is not familiar with the proper procedures of the patent office, then the examiner then may suggest that it is desirable for the inventor to obtain representation by a licensed patent attorney or agent."[31]

"The patent examiner cannot recommend a patent attorney or agent, but the patent office does post a list of registered attorneys or agents.

It is not uncommon for individual inventors to file their own patents to save thousands of dollars in agent/attorneys fees. Legal fees for the preparation and filing of a US patent application can run more than twenty thousand USD.

There are many self-help books in publication such as "patent it yourself "explaining how to file your own patent".[32] The U.S. patent office also has a free help line called the "Inventors Assistance Center" where retired patent examiners will provide advice to members of the public on how to follow the procedures and rules of the patent office.

The USPTO will accept patent applications filed in electronic form. As of March 2006, inventors or their patent agents/attorneys can file applications as pdf documents. The web

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[29] Wikipedia. Retrieved December 22, 2006 from http://en.wikipedia.org/wiki/Patent_attorney

[30] Wikipedia. Retrieved December 22, 2006 from http://en.wikipedia.org/wiki/Pro_se

[31] Manual of Patent Examining Procedure, Chapter 400. Retrieved May, 15, 2002 from http://www.uspto.gov/web/offices/pac/mpep/mpep_e8r3_0400.pdf

[32] Wikipedia. Retrieved December 22, 2006 from http://en.wikipedia.org/wiki/Patent

page for submitting applications is https://sportal.uspto.gov/secure/portal/efs-unregistered. Filing fees can be paid by credit card or by a USPTO "deposit account".[33]

1.4.2 MEDLINE:

MEDLINE is the United States National Library of Medicine's (NLM®) premier bibliographic database providing information from the following fields:

- Medicine
- Nursing
- Dentistry
- Veterinary medicine
- Allied health
- Pre-clinical sciences

"The MEDLINE database is the electronic counterpart of *Index Medicus*®, *Index to Dental Literature*, and the *International Nursing Index*."[34]

As well, MEDLINE is the primary source of global information from international literature on biomedicine, including the following topics as they relate to biomedicine and health care:

- Biology
- Environmental science
- Marine biology
- Plant and animal science
- Biophysics
- Chemistry

"The Ovid MEDLINE database contains bibliographic citations and author abstracts from more than 4,600 biomedical journals published in the United States and in seventy other countries. The database contains well over 12 million citations dating back to the mid-1960's, including more than 130,000 population-related journal citations (unique to the former

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[33] United States Patent and Trademark Office Retrieved December 22, 2006 from https://sportal.uspto.gov/secure/portal/efs-unregistered|

[34] Ovid Medline database Guide. Retrieved December 22, 2006 from http://www.ovid.com/site/products/ovidguide/medline.htm.

POPLINE® database) that were added to MEDLINE in October of 2002. Although coverage is worldwide, most records are derived from English-language sources or have English abstracts. Abstracts are included for more than 75% of the records.

NLM uses a controlled vocabulary of biomedical terms to index articles, to catalogue books and other holdings, and to facilitate searching within MEDLINE. MEDLINE’s controlled-vocabulary thesaurus contains Medical Subject Headings (MeSH®) to describe the subject of each journal article in the database. MeSH terms provide a consistent way of retrieving information that uses different terminology for the same concept. Within MEDLINE’s thesaurus, MeSH terms are displayed hierarchically by category with more specific terms arranged beneath broader terms. This hierarchical structure also provides an effective way for searchers to browse MeSH in order to find descriptors appropriate to their searches. http://www.nlm.nih.gov/.”[35]

1.4.3 The Science Citation Index:

“The *Science Citation Index* (SCI) was created first as an information retrieval tool and its use as a measurement instrument came later which appears to be better known. It provides access to current and retrospective bibliographic information, author abstracts, and cited references found in 3,700 of the world's leading scholarly science and technical journals covering more than 100 disciplines. The *Science Citation Index Expanded*™ format, available through the *Web of Science*® and the online version, SCI Search®, cover more than 5,800 journals.”[36]

The key advantages and capabilities of the Science Citation Index are as follows:

“The SCI allows researchers to conduct broad-based, comprehensive searches that uncover all relevant information.

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[35] Ovid MEDLINE® Database Guide. Retrieved December 22, 2006 from http://www.ovid.com/site/products/ovidguide/medline.htm.

[36] Garfield, Eugene (1995). Quantitative analysis of the scientific literature and its implications for science policymaking in Latin America and the Caribbean, Bulletin of the pan American health organization-special report, Vol. 29, No. 1, P. 87-95. Retrieved November 15, 2006 from http://www.garfield.library.upenn.edu/papers/paho29(1)p87y1995.pdf#search=%22quantitative%20analysis%20of%20the%20scientific%20literature%22.

It provides cited reference searching the unique ISI search and retrieval feature that lets users track the literature forward, backward and through the database, breaking through disciplinary and geographic boundaries.

It enables users to conduct multidisciplinary searches to discover hidden subject relationships.

The formats and delivery options of the Science Citation Index are as follows:

- DVD (format available from late 2004 forward) — with author abstracts: Updated monthly, includes annual cumulation on two discs; back-files to 1991. Without author abstracts: Updated quarterly, includes annual cumulation on one disc; back-files to 1980; networking options
- Online via distribution partners; updated weekly.
- SciSearch via DIALOG, DIMDI, and STN updated weekly; -1974.
- SciSearch via DataStar updated weekly; back-years to 1980."[37]

1.4.4 The United States Patent and Trademark Office (USPTO)

The USPTO "Rooted in the 200-year-old writings of the U.S. Constitution, the USPTO was established "to promote the progress of science and useful Arts, by securing for limited times to authors and inventors the exclusive right to their respective writings and discoveries."

The largest patent office in the world, the USPTO has around 7,300 employees, nearly all of whom are based in Alexandria, Virginia. Of those, about 3,000 are patent examiners and 400 are trademark examining attorneys, with the rest made up of support staff. The total number of applications per year to the USPTO has grown from roughly 250,000 in 2000 to over 400,000 in 2006."[38]

1.4.5 World Intellectual Property Organization (WIPO)

"World Intellectual Property Organization (WIPO) is a specialized agency of the United Nations. It is dedicated to developing a balanced and accessible international intellectual

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[37] Silvia, Elisabete A. Biblioteca (2003). Retrieved May 16, 2006 from: http://www.civil.ist.utl.pt/informacoes/biblioteca2.pdf.

[38] World Intellectual Property Organization. Retrieved November 17, 2006 from http://www.wipo.int/treaties/en/general/

property (IP) system, which rewards creativity, stimulates innovation and contributes to economic development while safeguarding the public interest.

WIPO was established by the WIPO Convention in 1967 with a mandate from its Member States to promote the protection of IP throughout the world through cooperation among states and in collaboration with other international organizations. Its headquarters are in Geneva, Switzerland.

The roots of the World Intellectual Property Organization go back to 1883, when Johannes Brahms was composing his third Symphony, Robert Louis Stevenson was writing Treasure Island, and John and Emily Roebling were completing construction of New York's Brooklyn Bridge.

The need for international protection of intellectual property became evident when foreign exhibitors refused to attend the International Exhibition of Inventions in Vienna in 1873 because they were afraid their ideas would be stolen and exploited commercially in other countries.

1883 marked the birth of the Paris Convention for the Protection of Industrial Property, the first major international treaty designed to help the people of one country obtain protection in other countries for their intellectual creations in the form of industrial property rights, known as:

- inventions (patents)
- trademarks
- industrial designs

The Paris Convention entered into force in 1884 with 14 member States, which set up an International Bureau to carry out administrative tasks, such as organizing meetings of the member States.

In 1886, copyright entered the international arena with the Berne Convention for the Protection of Literary and Artistic Works. The aim of this Convention was to help nationals of its member States obtain international protection of their right to control, and receive payment for, the use of their creative works such as:

- novels, short stories, poems, plays;
- songs, operas, musicals, sonatas; and
- drawings, paintings, sculptures, architectural works.

Like the Paris Convention, the Berne Convention set up an International Bureau to carry out administrative tasks. In 1893, these two small bureaux united to form an international organization called the United International Bureaux for the Protection of Intellectual Property (best known by its French acronym BIRPI). Based in Berne, Switzerland, with a staff of seven, this small organization was the predecessor of the World Intellectual Property Organization of today - a dynamic entity with 184 member States, a staff that now numbers some 938, from 95 countries around the world, and with a mission and a mandate that are constantly growing.

As the importance of intellectual property grew, the structure and form of the Organization changed as well. In 1960, BIRPI moved from Berne to Geneva to be closer to the United Nations and other international organizations in that city. A decade later, following the entry into force of the Convention Establishing the World Intellectual Property Organization, BIRPI became WIPO, undergoing structural and administrative reforms and acquiring a secretariat answerable to the member States.

In 1974, WIPO became a specialized agency of the United Nations system of organizations, with a mandate to administer intellectual property matters recognized by the member States of the UN.

In 1978, the WIPO Secretariat moved into the headquarters building that has now become a Geneva landmark, with spectacular views of the surrounding Swiss and French countryside.

WIPO expanded its role and further demonstrated the importance of intellectual property rights in the management of globalized trade in 1996 by entering into a cooperation agreement with the World Trade Organization (WTO).

The impetus that led to the Paris and Berne Conventions - the desire to promote creativity by protecting the works of the mind - has continued to power the work of the Organization, and its predecessor, for some 120 years. But the scope of the protection and the services provided have developed and expanded radically during that time.

In 1898, BIRPI administered only four international treaties. Today its successor, WIPO, administers 24 treaties (three of those jointly with other international organizations) and carries out a rich and varied program of work, through its member States and secretariat, that seeks to:

- harmonize national intellectual property legislation and procedures,
- provide services for international applications for industrial property rights,

- exchange intellectual property information,
- provide legal and technical assistance to developing and other countries,
- facilitate the resolution of private intellectual property disputes, and
- marshal information technology as a tool for storing, accessing, and using valuable intellectual property information."[39]

1.4.6 European Patent Office (EPO)

"Established in 1977 by the European Patent Convention (EPC) with the aim of creating a centralised patent application and grant system on behalf of all contracting states, the EPO's mission is to support innovation, competitiveness and economic growth for the benefit of the citizens of Europe. As of March 2007, the EPC has effect in 32 European countries, including all European Union member states - a market of nearly 600 million people."

The EPO examines and grants "European patents" which, subject to formal requirements, then acquire the same status and influence as national patents under the national laws of such EPC contracting states as the applicant designates.

At the end of 2006, the EPO had a total of 6,500 staff members, with roughly 3,500 examiners. Patent applications to the EPO have increased steadily in recent years; the number of total filings rising from 181,000 in 2004 to roughly 208,000 in 2006."[40]

1.4.7 World Economic Outlook Database (WEO)

The World Economic Outlook (WEO) database "is created during each semi-annual WEO exercise; these exercises begin in January and June of each year and culminate in the publication of the *World Economic Outlook* in April and September, respectively. Selected series from the publication are released on this website on the day of the WEO press conference. The World Economic Outlook (WEO) presents the International Monetary Found (IMF) staff's analysis and projections of economic developments at the global level, in major country groups (classified by region, stage of development, etc.), and in many individual

[39]World Intellectual Property Organization. Retrieved November 17, 2006 from http://www.wipo.int/treaties/en/general/

[40] The European patent Office. Retrieved May 25, 2007 from http://www.epo.org/focus/patent-system/patents-around-the-world.html

countries. It focuses on major economic policy issues as well as on the analysis of economic developments and prospects. It is usually prepared twice a year, as documentation for meetings of the International Monetary and Financial Committee, and forms the main instrument of the IMF's global surveillance activities."[41]

1.4.8 Bielefeld Academic Search Engine (BASE)

"BASE is the name of the multi-disciplinary search engine for scientifically relevant web resources which was created and developed by Bielefeld University Library. It is based on search technology provided by FAST Search & Transfer, a Norwegian company.

As the open access movement grows and prospers, more and more repository servers come into being which use the "Open Archives Initiative Protocol for Metadata Harvesting" (OAI-PMH) for providing their contents.

For the BASE project OAI metadata from scientific repository servers are collected by a so-called "harvester" and are indexed by means of FAST software. BASE is a registered OAI service provider and contributes to the European project "Digital Repository Infrastructure Vision for European Research" (DRIVER) since June 2006.

In addition to OAI metadata the library indexes selected web sites and local data collections, which can be searched via one single search interface in one go. In comparison to commercial search engines, BASE is distinguished for the following features:

1. Intellectually selected resources. 2. Only document servers that comply with the specific requirements of scientific quality and relevance are included. 3. A data resources inventory provides transparency in the searches. 4. Searches full text plus meta data (depending on the resource). 5. Discloses web resources of the "Deep Web", which are ignored by commercial search engines or get lost in the vast quantity of hits.

6. The display of search results includes precise bibliographic data (if provided in the resource)

7. Several options for sorting the result list. 8."Refine your search result" options (authors, resources, document type, language etc.)."[42]

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[41] The Worls Economic outlook database. Retrived May 25, 2007 from: http://www.imf.org/external/pubs/ft/weo/2006/01/data/dbginim.cfm.

[42] Bielefeld Academic Search Engine (BASE). Retrieved July 13, 2007 from http://www.base-search.net/

1.5 Definition of terms:

1.5.1 Jurisprudence:

Jurisprudence is the theory and philosophy of law. Scholars of jurisprudence, or legal philosophers, hope to obtain a deeper understanding of the nature of law, of legal reasoning, legal systems and of legal institutions. As jurisprudence has developed, there are three main aspects with which scholarly writing engages:

- Natural law is the idea that there are unchangeable laws of nature which govern us, and that our institutions should try to match this natural law.
- Analytic jurisprudence asks questions like, "What is law?" "What are the criteria for legal validity?" or "What is the relationship between law and morality?" and other such questions that legal philosophers may engage.
- Normative jurisprudence asks what law ought to be. It overlaps with moral and political philosophy, and includes questions of whether one ought to obey the law, on what grounds law-breakers might properly be punished, the proper uses and limits of regulation, how judges ought to decide cases.

Modern jurisprudence and philosophy of law is dominated today primarily by Western academics. The ideas of the Western legal tradition have become so pervasive throughout the world that it is tempting to see them as universal. Historically, however, many philosophers from other traditions have discussed the same questions, from Islamic scholars to the ancient Greeks."[43]

1.5.2 Scientific Literature:

"Scientific literature comprises scientific publications that report original empirical and theoretical work in the natural and social sciences, and is often abbreviated as the literature. Academic publishing is the process of placing the results of one's research into the literature.

Scientific literature is where scientific debates are properly adjudicated.

- Scientific literature can include the following kinds of publications:
- Scientific articles published in scientific journals
- Patents specialized for science and technology (for example, biological patents and chemical patents)

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[43] Wikipedia. Retrieved June 24, 2006 from: http://en.wikipedia.org/wiki/Wikipedia

- Books wholly written by one or a small number of authors being scientists
- Books, where each chapter is the responsibility of a different author or set of authors, though the editor may take some responsibility for ensuring consistency of style and content
- Presentations at academic conferences, especially those organized by learned societies
- Government reports
- Scientific publications on the World Wide Web
- Books, technical reports, pamphlets, and working papers issued by individual researchers or research organisations on their own initiative; these are sometimes organised into a series."

"The significance of these different components of the literature varies between disciplines and has changed over time. As of 2006, peer-reviewed journal articles remain the predominant publication type, and have the highest prestige. However, journals vary enormously in their prestige and importance, and the value of a published article depends on the journal. The significance of books, also called research monographs depends on the subject. Generally books published by university presses are usually considered more prestigious than those published by commercial presses. The status of working papers and conference proceedings depends on the discipline; they are typically more important in the applied sciences. The value of publication as a preprint or scientific report on the web has in the past been low, but in some subjects, such as mathematics or high energy physics, it is now an accepted alternative."[44]

1.5.3 Patent:

A patent is a right granted for any device, substance, method or process which is new, inventive and useful.

"A patent is legally enforceable and gives the owner the exclusive right to commercially exploit the invention for the life of the patent (This is not automatic; the inventor must apply for a patent (from a patent office) to obtain exclusive rights to exploit his or her invention)."[45]

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[44] Wikipedia. Retrieved June 24, 2006 from http://en.wikipedia.org/wiki/Scientific_literature.

[45] Types of Intellectual Property. Retrieved December 12, 2006 from http://www.smoorenburg.com.au/ipbasics/iptypes.html

The term of new patent issued by the United States Patent and Trademark Office is generally 20 years from the date on which the application for the patent was filed in the United States or, in special cases, from the date an earlier related application was filed, subject to the payment of maintenance fees. "U.S. patent grants are effective only within the United States, U.S. territories, and U.S. possessions. Under certain circumstances, patent term extensions or adjustments may be available.

The right conferred by the patent grant is, in the language of the statute and of the grant itself, "the right to exclude others from making, using, offering for sale, or selling" the invention in the United States or "importing" the invention into the United States. What is granted is not the right to make, use, offer for sale, sell or import, but the right to exclude others from making, using, offering for sale, selling or importing the invention. Once a patent is issued, the patentee must enforce the patent without aid of the USPTO."[46]

There are three types of patents:

1.5.3.1 "Utility patents:

Utility Patents may be granted to anyone who invents or discovers any new and useful process, machine, article of manufacture, or composition of matter, or any new and useful improvement." [47]

1.5.3.2 "Design patents:

Design patents may be granted to anyone who invents a new, original, and ornamental design for an article of manufacture."[48]

1.5.3.3 "Plant patents:

"*Plant patents* may be granted to anyone who invents or discovers and asexually reproduces any distinct and new variety of plant."[49]

1.5.3.4 Issue date:

Date at which patent protection can be enforced.

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[46] United States Patent and Trademark Office. Retrieved June 24, 2006 from http://www.uspto.gov/web/offices/pac/doc/general/index.html#patent.

[47] Kontaxx international. Retrieved June 24, 2006 from http://www.kontaxx.com/intelproperty.html.

[48] Ibid

[49] Ibid

1.5.3.5 Publication date:

Date at which application is laid-open to public inspection.

1.5.3.6 Priority date:

Date that subject matter was first filed in another foreign or domestic. Application must be no more than 1 year earlier than filing date.

1.5.3.7 priority application number

Application number of the first filing (patent).

1.5.3.8 Priority country

Country in which the first filing (patent filing) took place.

Although there may be some similarities among patents, copyrights, and trademarks, but they are different and serve different purposes.

1.5.4 Trademark or Servicemark:

“A trademark is a word, name, symbol, or device that is used in trade with goods to indicate the source of the goods and to distinguish them from the goods of others. A servicemark is the same as a trademark except that it identifies and distinguishes the source of a service rather than a product. The terms “trademark” and “mark” are commonly used to refer to both trademarks and servicemarks.”[50]

“Trademark rights may be used to prevent others from using a confusingly similar mark, but not to prevent others from making the same goods or from selling the same goods or services under a clearly different mark. Trademarks which are used in interstate or foreign commerce may be registered with the USPTO.”[51]

1.5.5 Copyright:

“Copyright is a form of protection provided to the authors of “original works of authorship” including literary, dramatic, musical, artistic, and certain other intellectual works, both published and unpublished. The 1976 Copyright Act generally gives the owner of copyright the exclusive right to reproduce the copyrighted work, to prepare derivative works, to

[50] Ibid

[51] Ibid

distribute copies or phonorecords of the copyrighted work, to perform the copyrighted work publicly, or to display the copyrighted work publicly."[52]

The copyright protects the form of expression rather than the subject matter of the writing. For example, a description of a machine could be copyrighted, but this would only prevent others from copying the description; it would not prevent others from writing a description of their own or from making and using the machine. Copyrights are registered by the Copyright Office of the Library of Congress.

"First patent law was enacted in 1790. The patent laws underwent a general revision which was enacted July 19, 1952, and which came into effect January 1, 1953. It is codified in Title 35, United States Code. Additionally, on November 29, 1999, Congress enacted the American Inventors Protection Act of 1999 (AIPA), which further revised the patent laws."[53]

The patent law specifies the subject matter for which a patent may be obtained and the conditions for patentability. The law establishes the United States Patent and Trademark Office to administer the law relating to the granting of patents and contains various other provisions relating to patents.

1.5.6 What Can Be Patented?

"The patent law specifies the general field of subject matter that can be patented and the conditions under which a patent may be obtained.

In the language of the statute, any person who "invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof, may obtain a patent," subject to the conditions and requirements of the law. The word "process" is defined by law as a process, act or method, and primarily includes industrial or technical processes. The term "machine" used in the statute needs no explanation. The term "manufacture" refers to articles that are made, and includes all manufactured articles. The term "composition of matter" relates to chemical compositions and may include mixtures of ingredients as well as new chemical compounds. These classes of subject matter taken

[52] Office of Technology Management,University of Illinois at Urbana, Champaign. Retrieved June 24, 2006 from http://www.otm.uiuc.edu/faculty/primer/copyright.asp.

[53] Public Law (1990). 106-113, 113 Stat. 1501.

together include practically everything that is made by man and the processes for making the products."[54]

1.5.7 Patent Literature:

All articles, notes, summaries, letters to the editors, reports, notices, discussions, etc. about patents in this study considered as patent literature.

1.5.8 Reference:

The cited article identified as a reference.[55]

1.5.9 Scientometrics:

As the method of this study is scientometric, it is necessary to define scientometrics and related terms and outline its main indicators.

"Bibliometrics and scientometrics are a set of methods for measuring the production and dissemination of scientific knowledge, which are often used in library and information science."[56]

"Bibliometrics is made up of methods for conducting quantitative analysis of science. Some of the methods serve to measure sociological aspects of one of the researcher's most important activities-dissemination of research results in published form.

"Bibliometrics is based on two assumptions: (1) the goal of researchers is to advance knowledge, and this means disseminating the results of their research and studies through a variety of communication media, including writing, which lies at the core of the academic tradition; (2) scholars have to publish in order to build a reputation and advance their careers.

A publication count is one means of measuring and comparing the production of various aggregates such as institutions, regions and countries. It can also be used to evaluate output in individual disciplines, such as philosophy and economics, and to track trends in research fields, collaborative research and many other aspects of research output."

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54 United State Patent and Trademark Office. Retrieved June 24, 2006 from http://www.uspto.gov/web/offices/pac/doc/general/what.htm.

55 Garfield, Eugene (1970). Citation index for studying science. Essays of an information scientist, Vol. 1, P. 133-138. Retrieved November 25, 2006 from http://www.garfield.library.upenn.edu/essays/V1p133y1962-73.pdf#search=%22citation%20indexing%20for%20studying%20science%22

56 Archambault, Eric ; Vignola-Gagne, Etienne; Côté, Grégoire ; Lrivière, Vincent and Gingras,Yves (2006). Benchmarking scientific output in the social sciences and humanities: The limits of existing databases. Scientometrics, Vol. 68, No. 3, p. 329–342.

"Bibliometrics uses three main types of indicator:"

1.5.10 Publication count

"The number of articles published in the journals during a specific time frame is an indicator of the output of a set or subset within the science system. It is also possible to compare numbers in order to measure output intensity in specific fields (specialization index)."

1.5.11 Estimation of Citations and Impact Factors

"Number of citations can be used to evaluate the scientific impact of research. The number of citations received by learned journals is systematically compiled by Thomson ISI and sold under the trademark *Journal Citation Reports* (JCI). This product includes a number of indicators related to citations received by journals, and the *impact factor* is probably the one most commonly applied."

1.5.12 Co-citation and co-word analysis

"Many co-citation-based indicators are used to map research activity: Co-citation analysis, co-word analysis, and bibliographic coupling. Mapping is a means of studying the development of emerging fields using time as a variable. Co-citation and co-word indicators can be combined with publication and citation counts to build multifaceted representations of research fields, linkages among them, and the actors who are shaping them".[57]

"Bibliometrics utilizes quantitative analysis and statistics to describe patterns of publication within a given field or body of literature. Researchers may use bibliometric methods of evaluation to determine the influence of a single writer, or to describe the relationship between two or more writers or works. One common way of conducting bibliometric research is to use the *Social Science Citation Index*, the *Science Citation Index* or the *Arts and Humanities Citation Index* to trace citations[58].

"The terms *bibliometrics* and *scientometrics* have been introduced almost simultaneously by Pritchard and by Nalimov and Mulchenko in 1969."[59] While Pritchard explained the term

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[57] Archambault, Éric and Gagné, Étienne Vignola (2004): The Use of Bibliometrics in the Social Sciences and Humanities. Retrieved June 13, 2009 from http://www.science-metrix.com/pdf/SM_2004_008_SSHRC_Bibliometrics_Social_Science.pdf.

[58] Bibliometrics. Retrieved August 19, 2006 from http://www.gslis.utexas.edu/~palmquis/courses/biblio.html

[59] Authors who agree that Pritchard coined the biblimetric method include Fairthorne (1969), Lawani (1980), Hertzel (1987), Brookes (1988), White & McCain (1989), Soper et al. (1990) and Khurshid & Sahai (1991a). However, Wilson (1995) indicates that this term has a French precedent. Fonseca (1973), in a criticism of the

bibliometrics as "the application of mathematical and statistical methods to books and other media of communication" [60], Nalimov and Mulchenko defined scientometrics as "the application of those quantitative methods which are dealing with the analysis of science viewed as an information process" [61]. "According to these interpretations, scientometrics is restricted to the measurement of science communication, whereas bibliometrics is designed to deal with more general information processes."[62]

"The anyhow fuzzy borderlines between the two specialities almost vanished during the last three decades, and nowadays both terms are used almost as synonyms. Instead, the field *informetrics* took the place of the originally broader speciality bibliometrics. The term informetrics was adopted by VINITI[63] and stands for a more general subfield of *information science* dealing with mathematical-statistical analysis of communication processes in science. In contrast to the original definition of bibliometrics, informetrics also deals with electronic media and thus includes topics such as the statistical analysis of the (scientific) text and hypertext systems, library circulations, information measures in electronic libraries, models for Information Production Processes and quantitative aspects of information retrieval as well. In his review entitled "Biblio-, sciento-, infor-metrics What are we talking about"[64] gave an interesting overview about origin and contexts of these metrics of science, literature and information in general. According to the description of *Glänzel* and *Schoepflin*, bibliometrics and informetrics include "all quantitative aspects and models of science communication,

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tendency of English-language authors to ignore works in Romance languages, draws attention to the use of the French equivalent of the term, 'bibliometrie', by Paul Otlet (1934) in his Traitée de Documentation. Le livre sur le Livre. Theorie et Pratique – hardly an obscure work. Section 124, pp.13-22, of this text is entitled 'Le Livre et la Mesure. Bibliometrie.' Though Otlet (1934) had previously employed the term 'bibliometrie', Pritchard (1969b, p. 348) defined the new bibliometrics widely, to be "the application of mathematical and statistical methods to books and other media of communication". In the same year, Fairthorne (1969, p. 341) widened its ambit claim even further to the "quantitative treatment of the properties of recorded discourse and behaviour appertaining to it". (Other definitions are given below.) By 1970 bibliometrics had become a heading in both Library Literature and in Library and Information Science Abstracts, (Peritz, 1984) and by 1980 a Library of Congress Subject Heading (Broadus, 1987b).

[60] Pritchard, A.(1969). Statistical bibliography or bibliometrics? Journal of Documentation 24, p. 348-349.

[61] Nalimov, V. V. and Mulchenkov, Z.M.(1969). Naukometria, nauka. Moscow.

[62] Ibid

[63] Gorkova, V.I (1988). Informetrics, Informatics, 10, VINITI, Moscow.

[64] Brookes B. C.(1970). The growth, utility, and obsolescence of scientific periodical literature. Journal of Documentation, Vol. 26, No. 4, p. 283-94.

storage, dissemination and retrieval of scientific information." [65] "Informetrie (*engl.:informetrics)* beschäftigt sich mit der Messbarkeit von Information in Dokumenten aller Art. Sie ist damit nicht nur auf Bücher, Zeitschriften und andere Publikationen beschränkt, sondern bezieht sich auch auf Dokumente aus Archiven Dokumentationseinrichtungen und dem Internet. Ihre Methoden sind grundsätzlich statistischer Art. Sie kann als Oberbegriff der Bibliometrie, Cybermetrics, Patentometrie und in gewissem Rahmen auch der Szientometrie verstanden werden."[66] ??

"In fact the origin of statistical studies on scientific bibliographies goes back to the twenties of the last century. In 1926, *Alfred J. Lotka* published his pioneering study on the frequency distribution of scientific productivity[67]. Almost at the same time, in 1927, *Gross* and *Gross* published their citation-based study in order to aid the decision which chemistry periodicals should best purchased by small college libraries[68]. In particular, they examined 3633 citations from the 1926 volume of the *Journal of the American Chemical Society*. This study is considered the first citation analysis, although it is not a citation analysis in the sense of present-day bibliometrics[69].

"A few years after Lotka's article (8 years), Bradford published his study on the frequency distribution of papers over journals."[70] He established a relationship concerning the frequency distribution of papers over journals In particular, he found that "if scientific journals are arranged in order of decreasing productivity on a given subject, they may be divided into a nucleus of journals more particularly devoted to the subject and several groups or zones containing the same number of articles as the nucleus when the numbers of periodicals in the nucleus and the succeeding zones will be as1 : b : b² …".

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[65] Braun, T., Glänzel, W. and Schubert, A. (1985). Scientometric Indicators. A 32 Country Comparison of Publication Productivity and Citation Impact. World Scientific Publishing Co. Pte. Ltd., Singapore, Philadelphia.

[66] Umstätter, W. (2004) Szientometrische Verfahren. In: Grundlagen der praktischen Information und Dokumentation. Hrsg.: Rainer Kuhlen, Thomas Seeger, Dietmar Strauch. 5., vollst. neu gefasste Ausgabe. – München: Saur . Retrieved August 28, 2007 from http://hub.ib.hu-berlin.de/~wumsta/infopub/pub2001f/sziento04.pdf

[67] Lotka AJ,(1926). J WASH ACAD SCI, P16.

[68] GROSS, P.L.K., Gross, E.M (1927). College Libraries and Chemical Education, Science, 66, p. 385-389.

[69] Glänzel, Wolfgang.(2003). Bibliometrics as A research field. A course on theory and application of bibliometric indicators. Retrieved May 10, 2006 from http://www.norslis.net/2004/Bib_Module_KUL.pdf

[70] Bradford SC, (1934). Engineering, London V137.

"Bibliometrics took a sharp rise since the late sixties is reflected by remarkable academic activities, and is intimately connected with the advanced information technology, with the development in computer science and technology and, especially, with the worldwide availability of the large bibliographic databases serving as the ground work of bibliometric research. Especially the databases of the Institute for Scientific Information (ISI, Philadelphia, PA, USA), should be mentioned in this context. The source of bibliometrics is always a database."

"The SCI and more recently the *Web of Science* have become the most generally accepted basic source for bibliometric analysis."[71]

"In the 90s, bibliometrics has become a standard tool of science policy and research management. In particular, all significant compilations of science indicators heavily rely on publication and citation statistics and other, more sophisticated bibliometric techniques."[72]

"However, it was only with the advent of the tools developed by the Institute for Scientific

Information (now Thomson ISI) and the research conducted by its founder, Eugene Garfield, that the use of bibliometrics became widespread. With their systematic archiving of articles from a selection of some of the most prestigious and most often cited scholarly journals, the Thomson ISI databases considerably reduce the effort required to carry out bibliometric analysis."[73] "The field grew out the sociology of science, information science and library science, but it quickly carved out a place for itself in quantitative research evaluation."[74]

Wolfgang Glänzel describes the aims of bibliometric research as follow:

"1. Bibliometrics for bibliometricians ("Basic research" in bibliometrics)

This is the domain of basic bibliometric research and is traditionally funded by the usual grants. Methodological research is conducted mainly in this domain.

2. Bibliometrics for scientific disciplines (Scientific information)

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[71]Glänzel, Wolfgang.(2003). Bibliometrics as A research field. A course on theory and application of bibliometric indicators. Retrieved May 10, 2006 from http://www.norslis.net/2004/Bib_Module_KUL.pdf

[72] Glänzel, Wolfgang (2006). The origin of the term "Bibliometrics". Retrieved Janury 15, 2006 from http://www.steunpuntoos.be/bibliometrics.html.

[73] Archambault, Éric ; Vignola-Gagné, Étienne ; Côté, Grégoire ; Larivière, Vincent and Gingras, Yves. Welcome to the linguistic warp zone: Benchmarking scientific output in the social sciences and humanities. Retrieved December 18, 2006 from

http://www.ost.uqam.ca/OST/pdf/articles/2005/Linguistic_Warp_Zone_Benchmarking_SSH.pdf

[74]Ibid

The researchers in scientific disciplines form the bigger, but also the most diverse interest-group in bibliometrics. Due to their primary scientific orientation, their interests are strongly related to their speciality. This domain may be considered an extension of *science information* by metric means. Here we also find joint borderland with quantitative research in *information retrieval.*

3. Bibliometrics for science policy and management (Research evaluation)

This is the domain of *research evaluation*, at present the most important topic in the field. Here the national, regional, and institutional structures of science and their comparative presentation are in the foreground."[75]

Bibliometrics - as a truly interdisciplinary field - has strong links with related research fields and fields of applications and services. Bibliometrics is traditionally strongly related with library science, information retrieval and sociology of science, on the other hand, results of bibliomertric research and technology are applied as services for librarianship, scientific information and science policy.

1.5.13 Citation Classics

Citation Classics „Sind Publikationen, die durch eine besonders lang andauernde Zitierung überdurchschnittlich hohe Zitationsraten, in überdurchschnittlich hohen Halbwertszeiten erreichen. Sie beziehen sich meist auf klassische Arbeiten und führen damit zu einer leichten Abweichung (insgesamt etwa 5%) von der typischen Halbwertszeitfunktion bei weit zurückliegenden Publikationen..“[76]

"Citation Classic is a highly cited publication as identified by the Science Citation Index (SCI) the Social Sciences Citation Index (SSCI), or the Arts & Humanities Citation Index (A&HCI). Citation rates differ for each discipline. The number of citations indicating a classic in botany, a small field, might be lower than the number required to make a classic in a large field like biochemistry. In general, a publication cited more than 400 times should be

[75] Glänzel, Wolfgang. A Concise Introduction to Bibliometrics & its History. Retrieved June 13, 2006 from http://www.steunpuntoos.be/bibliometrics.html.

[76] Umstätter, W. (2004) Szientometrische Verfahren. In: Grundlagen der praktischen Information und Dokumentation. Hrsg.: Rainer Kuhlen, Thomas Seeger, Dietmar Strauch. 5., vollst. neu gefasste Ausgabe. – München: Saur.

considered a classic; but in some fields with fewer researchers, 100 citations might qualify a work. “[77] .

1.5.14 Most cited articles

Most cited articles or highly cited articles. “ Sind Publikationen, die durch eine besonders plötzlich auftretende häufige Zitierung überdurchschnittlich hohe Zitationsraten, in meist sehr kurzen Halbwertszeiten erreichen.“[78]

1.5.15 Half life

„Halbwertszeit ist die Zeit, in der eine Exponentialfunktion der Form C = C0 * e -p * t vom Ausgangswert C0 abgesunken ist auf C0/2. Dabei ist e die Basis des natürlichen Logarithmus, p eine Konstante die sich aus ln2/t½ ergibt und t die Zeit.“[79]

1.5.16 Doubling rate

„Verdopplungsrate ist die Zeit, in der eine Exponentialfunktion der Form C = C0 * e p * t vom Ausgangswert C0 auf 2C0 angestiegen ist Dabei ist e die Basis des natürlichen Logarithmus, p eine Konstante die sich aus ln2/t2 ergibt und t die Zeit.“[80]

1.5.17 The cited half-life:

“Cited half-life is a measurement used to estimate the impact of a journal. It is the number of years, going back from the current year, that account for 50% of the total citations received by the cited journal in the current year. ISI developed this calculation to provide an indicator as to the long-term value of source items in a single journal publication. The cited half life calculation appears only in the *Journal Citation Reports*® (*JCR*®)”[81]

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[77] Garfield, Eugene. Short History of Citation Classics Commentaries. Retrieved Auhust 24, 2007 from http://www.garfield.library.upenn.edu/classics.html

[78] Umstätter, W. (2004) Szientometrische Verfahren. In: Grundlagen der praktischen Information und Dokumentation. Hrsg.: Rainer Kuhlen, Thomas Seeger, Dietmar Strauch. 5., vollst. neu gefasste Ausgabe. – München: Saur.

[79] Ibid

[80] Ibid

[81] Glossary of Thomson Scientific terminology. Retrieved August 28, 2007 from http://scientific.thomson.com/support/patents/patinf/terms/

2 Problem statement:

"The ability to judge a nation's scientific standing is vital for the governments, businesses and trusts that must decide scientific priorities and funding."[82]

The research capacity of a country determines its development, and influences wealth creation and distribution. Determining the innovation activities in order to understand the role of scientists and researchers in a country is a crucial aspect of wealth creation. Scientists and researchers are potential wealth creators in an organization as well as in a country. There is a need to evaluate the performance of scientists and researchers of countries and to evaluate their scientific activities in different forms in order to be aware of trend of innovative activities by scientists and researchers to divert the innovative activities where the need is greater. Doing this requires an evaluation mechanism. Scientific output particularly patents are good indicators of innovative activity; they "reflect the inventive performance of countries, regions, technologies, firms, etc. They can also be used to track the level of diffusion of knowledge across technology areas, countries, sectors, firms, etc., and the level of internationalisation of innovative activities"[83]; hence they are a key measure of innovation output. Patents are often used to cite the learning experience and benefit of engaging in research and development (R&D) activities, to assess the quality of technical knowledge and the intensity of specialization in high technology in a country.

"To capture the relationship between science and technology, citation studies usually established a link through non-patent cited in patent. This means those patents are considered a representation of technology, while paper and citation to patents are viewed as representation of science. Citation study employs a quasi-organizational definition of science and technology."[84]

"Patent data has been used to study knowledge transfer for three reasons. The first is simple availability. Patent data offers a unique record of information concerning the characteristics of an invention, the identity of inventors, the identity of the inventors' employer, the date of filing (an approximation of the date of invention), and other useful information. In addition,

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[82] King, D. A. (2004). The scientific impact of nations. Nature, Vo.l 439, p. 311-316. Retrieved January 11, 2006 from http://www.britischebotschaft.de/en/embassy/r&t/research_spending_nf.pdf.

[83] Compendium of Patent Statistics 2004.Retrieved July 12, 2006 from http://europa.eu.int/estatref/info/sdds/en/pat/pat_compendium_2004.pdf

[84] Meyer, Martin (2000), Does science push technology? Patents citing scientific literature. Research Policy, Vol. 29, p. 409-434.

studies that also include patent licensing data can track the specific firms that develop a given invention and may even estimate the value created by measuring royalty income collected by the inventor. The second reason is commercial application. Since a wide variety of research is conducted at universities, much of which has little apparent commercial application, patent data offers a sub-sample of inventions that are more likely to be commercially viable. Third is growth in patenting activity."[85]

This study endeavours to explore the relationship between the innovation and scientific activities, and the amount of GDP in countries, and to illustrate the trend of patent literature in MEDLINE and in the Science Citation Index over a period of 40 years (1965-2005).

The findings of this study may be useful to illustrate and determine the role of scientists and researchers which involved themselves with innovation activities and the reflection of their activities in the form of patent literature in MEDLINE and in the Science Citation Index. Furthermore the results of this study will present the relationship between countries and their productivity.

3 Significance of study:

The idea that research activities are the processes of wealth creation and wealth is the requirement of research activity, we should bear in mind that the research capacity of a country determines its development, and influences wealth creation and distribution.

One of the great concerns of science policy makers is to find an objective and reliable way to evaluate the performance of their national scientific system and to determine their real situation among other organizations and countries in the world. To achieve this goal, there is a need to evaluate the performance of scientist and researchers of countries and to map their scientific output.

"Accurate recognition of the trends of scientific research is not only necessary to enable researchers to plan research projects, but is also useful for research organizations such as

[85] Agrawal, Ajay and Henderson, Rebecca (2002). Putting Patents in Context: Exploring Knowledge Transfer from MIT, Management Science,Vol.48, No.1, p. 44-60. Retrieved November 3, 2006 from http://www.rotman.utoronto.ca/Ajay.Agrawal/Documents/Agrawal-Henderson-Patent.pdf.

universities, faculties or departments, academic societies and organizations related to science policy that wish to improve research systems and effectively promote research activities."[86]

"Analysis of the literature can give science policymakers a unique and systematic overview of the research they administer and found in the terms of national, institutional, and individual performance (output and impact)."[87]

This requires an evaluation mechanism.

Since patent statistics provide elements for measuring the results of resources invested in research and development activities, and most particularly trends in technical change over time, they are increasingly being used as science and technology indicators; They reflect the inventive performance of countries, regions, technologies, firms, etc., And therefore can be used to track the level of diffusion of knowledge across technology areas, countries, sectors, firms, etc., and the level of internationalisation of innovative activities. Their literature can be used as a key measure of innovation output. The special proximity of patents to the output of industrial research and development (R&D) and other inventive and innovative activities means that there is no other equivalent indicator for this purpose.

There are four kinds of Scientometrics analysis:

- Paper citing papers.
- Patent citing patents.
- Paper citing patents
- Patent citing papers.

"Recent years have seen a major upsurge in patenting, an expansion of the range of innovations which are eligible for patent protection and a perception that the United States economy relies more and more heavily on knowledge and innovation for its success."[88]

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[86] A Study of International Comparison of the Number of Scientific Papers. Retrieved October 17, 2006 from http://www.nii.ac.jp/ENEWS/NL14/1412.html

[87] Garfield, Eugene (1995). Quantitative analysis of the scientific literature and its implications for science policymaking in Latin America and the Caribbean, Bulletin of the pan American health organization-special report, Vol. 29, No.1, P. 87-95.

[88]Merrill, Stephen A.; Levin,Richard C. and Mark B.(2004). A patent system for the 21st century, national research council of the national academies. Retrieved January 20, 2006 from http://books.nap.edu/html/patentsystem/0309089107.pdf.

"Patents and publications have been used as proxy indicators of technological and scientific activity, and interactions between science and technology (T&S) have been interpreted based on varied types of linkage shown by these proxy indicators. Tracking citation in patents of the scientific literature has been one of the methods to determine the linkage between science and technology."[89]

References to scientific literature as an outcome of technological and scientific progress determine the existence linkages between science and technology and vice versa. References to patents in scientific literature can provide insight in illustrating the nature of interactions between science and technology.

It seems to be necessary to study patents as proxy indicators of technological development and publications as an indicator of scientific activity by way of patent citation.

This study aims to investigate:

- The trend of innovation activities and reflection of their literature in MEDLINE and in the Since Citation Index for a period of 40 years (1965-2005)
- The trend of citations to the patents throughout 1996-1999
- The influence of country's wealth (GDP) on the scientific activities

The findings of this study may be useful to illustrate and determine the role of scientists, researchers and organizations of countries, and to map the reflection of innovation in the form of patents in MEDLINE and in the Science Citation Index. Furthermore, the results of this study will demonstrate the relationship between GDP of countries and their innovative activities.

4 Method and Materials:

The field of study:

"Patent literature" in this study is defined as all publication materials such as articles, reviews, note, letters, editorial-materials, meeting-abstracts, reprints, news-items, bibliographical-items, and discussions about patent, since these materials are outcomes of scientific activity in

[89] Bhattacharya, Sujit; Kretschmer,Hildrun and Meyer Martin (2003). Characterizing intellectual spaces between science and technology, Scientometrics, Vol. 58, No. 2, p.369.390.

institutes, organizations, and countries. They are appropriate materials for studying multifaceted relationships between science and technology as well as scientific activity and progress.

The Patent literature is part of the larger scientific literature and is composed of specific discipline literature as well as that of other basic scientific disciplines. “Scientific literature is the principal medium for communicating the results of scientific research and represents a permanent record of the collective achievements of the scientific community.”[90]

“Scientific literature is divided into two basic categories - "primary" and "secondary". Publications that report the results of original scientific research constitute the "primary" literature and include journal papers, conference papers, monographic series, technical reports, theses, and dissertations. The "primary" literature is eventually compacted into "secondary" sources, which synthesize and condense what is known of specific topics. These include reviews, monographs, textbooks, treatises, handbooks, and manuals.

“Availability of scientific literature varies depending upon its publication format. Some formats are widely available, e.g., journal papers, while others have limited distribution and are difficult to identify and acquire. This "gray literature" commonly includes technical reports, theses, and dissertations.”[91]

“There are many ways to study the relationship between science and technology and to illustrate their influences in the countries. Scientometrics analysis of the relation between scholarly literature and patent documents is one of them which use numerous parameters, such as scientific literature (articles, etc.), citations, patents, co-authorship, and so on. Much information may be taken from patent literature and their accompanying documentation, such as references to patents and scientific articles. This study engaged itself with patent literature (scientific output in different forms).

Scientometrics and data analyze provide information on the scientific orientation and dynamism of an organization and a country and its participation in science and technology world wide, in other words its impact on both the national and international community.”[92]

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[90] HSU Library, The Literature of Oceanography. Retrieved December 21, 2006 from http://library.humboldt.edu/~rls/litocean.htm.

[91] The Literature of Biology. Retrieved December 21, 2006 from http://library.humboldt.edu/~rls/litbiology.htm.

[92] Okubo, Yoshiko. Bibliometric indicators and analysis of research systems: Methods and examples. Retrieved December 21, 2006 from

This study assesses the Patent Literature (all articles, notes, summaries, letters to the editors, reports, notices, discussions, etc. about patents) published through 1965 – 2005 including in PubMed and the Science Citation Index. Extracting of data in PubMed was limited to MEDLINE by selecting MEDLINE from the Subsets menu on the Limits screen.

4.1 Delimitation of the patent literature:

1. The delimitation of the patent literature was made as follows:

- All records indexed as a main heading of "Patents" limited to the field of "*MeSH Major Topic"* in PubMed and in ERL for a period of 40 years (1965-2005). These topics belonged to the countries all around the world, their publications published in Periodicals, which MEDLINE provides access to them.
- All documents restricted to the "Patents" topic indexed in the Science Citation Index / web of Science (1965-2005). The choice of this database was guided by the fact"it attempts to cover respective journals in science and technology. Moreover this database is suitable in science and technology studies as it tracks the citations (citing as well as cited)."[93]

4.2 Data source and data processing:

- All USPTO patents data were extracted from the office of electronic information products / patent technology monitoring division. WIPO and EPO patents data were extracted from the websites of World's Intellectual Organization (http://www.wipo.int/portal/index.html.en) and European Patent Organization (http://www.epo.org/) respectively.
- To determin the influence of wealth in a country to the increase of publications as well as the increase amount of patent applications by countries; the GDP (Gross Domestic

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http://www.olis.oecd.org/olis/1997doc.nsf/43bb6130e5e86e5fc12569fa005d004c/0063b000bf535266c125645e0042dab3/$FILE/05E79150.DOC.

[93] The ISI indexes do not claim to have complete journal coverage, but rather to include the most important. Their founder, Eugene Garfield, developed a powerful and unique criterion for expanding the database beyond the core of journals whose importance to a given field is obvious: the frequency at which journals are cited in those source that are already included in the index.

Product)[94] of countries was extracted from the server of “International Monetary Fund”[95]. The number of patent applications, and the amount of publications by countries was calculaulated versus their GDP.

- All cited patents (citation to the patents) indexed in the 1995-1999 annual volumes of the CD-Edition of the Science Citation Index (SCI) of the Institute for Scientific Information (ISI) were taken into consideration, in order to illustrate the half-life of citations to the patents and comparing them with the half-life of citations to the general scientific publications during the same period.
- To determine the half-life of citations to the general scientific literature, about 60,000 references for each year of under study randomly were chosen from the SCI. the half-life of citations was calculated.
- References to patents have been identified through patents numbers that appear instead of the first authors name in the reference search string of the “cited authors / reference” field.

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[94] A region's gross domestic product,or GDP, is one of several measures of the size of its economy. The GDP of a country is defined as the market value of all final goods and services produced within a country in a given period of time. It is also considered the sum of value added at every stage of production of all final goods and services produced within a country in a given period of time. Until the 1980s the term GNP or gross national product was used in the United States(USA). The two terms GDP and GNP are almost identical - and yet entirely different; GDP being concerned with the region in which income is generated and GNP (or GNI - Gross National Income) being a measure of the accrual of income to a region.

The most common approach to measuring and understanding GDP is the expenditure method:

GDP = consumption + investment + (government spending-taxes) + (exports ? imports)

"Gross" means depreciation of capital stock is not included. With depreciation, with net investment instead of gross investment, it is the net domestic product. Consumption and investment in this equation are the expenditure on final goods and services. The exports minus imports part of the equation (often called cumulative exports) then adjusts this by subtracting the part of this expenditure not produced domestically (the imports), and adding back in domestic production not consumed at home (the exports).

[95] The IMF is an international organization of 184 member countries. It was established to promote international monetary cooperation, exchange stability, and orderly exchange arrangements; to foster economic growth and high levels of employment; and to provide temporary financial assistance to countries to help ease balance of payments adjustment. Since the IMF was established its purposes have remained unchanged but its operations—which involve surveillance, financial assistance, and technical assistance—have developed to meet the changing needs of its member countries in an evolving world economy.

http://www.imf.org/external/pubs/ft/weo/2006/01/data/index.htm.

- The kind of languages and the countries where the patent literature have been published was determined. The patent Literature subjects, those their frequency were higher than 50 times during the period of study signed as big Main Heading Group and named in the group.
- To determine the trend of mean value for cited references per paper, a total number of 10,000 records for each year of under study were randomly chosen in the SCI throughout 1970-2005. The men value of cited references per paper was calculated.
- To determine the growth of journals Impact Factor, all journals IF indexed in the JCR throughout 1999-2005 were extracted and the mean value of their IF was calculated annually.
- To show the difference of journals IF, all journals indexed in the JCR in 2002 were selected and the IF of the same set of journals in 2003 and 2004 extracted from the JCR.
- To determine the trend of self-citation of journals, a total number of 500 journals were randomly chosen in the JCR in 2005 and the same set of journals in the year 2000. If a journal was published in the year 2000 and it was cancelled in 20005 or it was published in 2005 but such journal was not found in 2000 (its publishing date was after 2000), an alternative journal which was published both in 2000 and 2005 was selected.
- To show the trend of languages for scientific publications through 1995-2006, a total number of 3,303,899 documents were extracted from Bielefeld Academic Search Engine (BASE). The trend of languages throgh 1995-2006 were determined. These documets were from 34 database all around the world that BASE makes access to them.
- GDP of countries was extracted from the database of World Economic Outlook.[96]
- The size of population in the countries was extracted from the database of CIA[97] (The World Factbook).

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[96] International Monetary Fund. Retrieved August 23, 2006 from http://www.imf.org/external/pubs/ft/weo/2006/01/data/dbginim.cfm.

[97] Central Intelligence Agency. Retrieved August 23, 2006 from https://www.cia.gov/index.html

4.2.1 A sample of MEDLINE's Record:

Verbeure B et al.: Patent pools and diagnostic t...[PMID: 16443296]

PMID- 16443296

OWN – NLM

STAT- MEDLINE

DA - 20060306

DCOM- 20060602

PUBM- Print-Electronic

IS - 0167-7799 (Print)

VI - 24

IP - 3

DP - 2006 Mar

TI - Patent pools and diagnostic testing.

PG - 115-20

AB - There is increasing concern that overlapping patents in the field of genetics will create a costly and legally complex situation known as a patent thicket, which, along with the associated issues of accumulating royalty payments, can act as a disincentive for innovation. One potential means of preventing this is for the patent holders to enter into a so-called patent pool, such as those established in the electronics and telecommunications industries. Precedents for these also exist in the field of genetics, notably with the patents pertaining to the SARS genome. In this review, we initially address the patent pool concept in general and its application in genetics. Following this, we will explore patent pools in the diagnostic field in more detail, and examine some existing and novel examples of patent pools in genetics.

AD - Centre for Intellectual Property Rights, Faculty of Law, University of Leuven, Belgium. birgit.verbeure@law.kuleuven.be

FAU - Verbeure, Birgit

AU - Verbeure B

FAU - van Zimmeren, Esther

AU - van Zimmeren E

FAU - Matthijs, Gert

AU - Matthijs G

FAU - Van Overwalle, Geertrui

AU - Van Overwalle G

LA - eng

PT - Journal Article

PT - Review

DEP - 20060127

PL - England

TA - Trends Biotechnol

JT - Trends in biotechnology.

JID - 8310903

SB - IM

MH - Animals

MH - *Genetics/economics/legislation & jurisprudence/trends

MH - Genome, Viral/genetics

MH - Humans

MH - *Laboratory Techniques and Procedures/economics/trends

MH - *Patents

MH - Research Support, Non-U.S. Gov't

MH - SARS Virus/genetics

RF - 36

EDAT- 2006/01/31 09:00

MHDA- 2006/06/03 09:00

PHST- 2005/06/17 [received]

PHST- 2005/10/13 [revised]

PHST- 2006/01/11 [accepted]

PHST- 2006/01/27 [aheadofprint]

AID - S0167-7799(06)00019-9 [pii]

AID - 10.1016/j.tibtech.2006.01.002 [doi]

PST - ppublish

SO - Trends Biotechnol. 2006 Mar;24(3):115-20. Epub 2006 Jan 27.

The two-letter terms in the left column are abbreviations for the various fields. For example, **AU** stands for **author**. This article has four authors, and the MEDLINE record uses four author fields, each containing the name of one of the authors. If we were to search the author field of the MEDLINE database, using one of these three names, we would locate this article plus any other articles by the same author.

TI stands for **title**, and this field contains the title of the article. If we were to search the title field of the MEDLINE database, using one of the main words in the title, we would find this article plus other articles with the same word in their titles.

4.2.2 Using Field Tags in Advanced Search in the SCI:

TS	Topic
TI	Title (article title)
AU	Author
GP	Group Author
SO	Source (journal title)
PY	Publication Year
AD	Address
OG	Organization*
SG	Suborganization*
SA	Street Address*
CI	City*
PS	Province/State*
CU	Country*
ZP	Zip/Postal Code*

Note: Fields marked with an asterisk (*) are all subfields of Address

4.2.3 A sample of Science Citation Index's (SCI) record:

SCI CDE with Abstracts (Jan 99 - Dec 99) (D4.1)

Record 1 of 14085.

Authors: Zhang-JG Zhang-TL Lu-Z Yu-KB

Title: Preparation and Crystal-Structure of (Ag(to)(2))ClO4-Center-Dot-H2O

Full source: ACTA CHIMICA SINICA 1999, Vol 57, Iss 11, pp 1233-1238

Language: Chinese

Document type: Article

IDS/Book No.: 257LT

No. Related Records: 3

No. cited references: 10

Addresses: BEIJING-INST-TECHNOL, DEPT MECHANOELECT ENGN, BEIJING 100081, PEOPLES-R-CHINA

CHINESE-ACAD-SCI, CHENGDU BRANCH, CTR ANAL & MEASUREMENT, CHENGDU 610041, PEOPLES-R-CHINA

Author keywords: Preparation; 1,2,4-Triazol-5-One(to); Silver Complex; Crystal Structure

KeyWords Plus: THERMAL-DECOMPOSITION MECHANISM

Abstract: [Ag(TO)(2)]ClO4. H2O was prepared by mixing the aqueous solution of 1,2,4 - triazol - 5 - one(TO) and silver perchlorate, It was characterized by X - ray diffraction, TG - DTG, and IR measurement. The crystalistriclinic, space group P (1) over bar with a = 0.533(1)nm, b = 0.938(1)nm, c = 1.220(1)nm; alpha = 88.02(1)degrees, beta = 79.50(1)degrees, gamma = 82.86(1)degrees; V = 0.5953(8)nm(3), Z = 2, R is 0.0281. The silver atom has a slightly bent linear coordination geometry with two nitrogen atoms.

Cited references:

004927940-US-1990-BOUDAKIAN-MM

CHEN-BR-1988-HUO-ZHAYAO-V4-P33

DAI-AB-1987-12-VOLUME-INORGANIC-P61

HU-RZ-1997-THERMOCHIM-ACTA-V299-P87

MANCHOT-W-1905-LIEBIGS-ANN-CHEM-V343-P1

SONG-J-1996-CHINESE-SCI-BULL-V41-P1953

XING-QY-1994-BASIC-ORGANIC-CHEM-P166

XU-GX-1992-QUANTUM-CHEM-P203

ZHANG-TL-1994-ACTA-CHIM-SINICA-V52-P545

ZHOU-GD-1982-MEASUREMENT-CRYSTAL-P289

The first one in the field of Cited Reference (004927940-US-1990-BOUDAKIAN-MM) is a citation to a patent; in this case it is a USPTO patent.

This study endeavours to extract all citations to patents, in order to determine the half-life of citations to patents.

4.2.4 A sample of Journal Science Reports (JCR):

Abbreviated Journal Title ***(linked to journal information)***	**ISSN**	**Total Cites**	**Impact Factor**	**Immediacy Index**	**Articles**	**Cited half-life**
AAPG BULL	0149-1423	4586	1.350	0.227	75	>10.0
AAPS J	1550-7416	31	1.100	0.108	83	
AAPS PHARMSCI	1522-1059	419	2.417		0	4.2
AATCC REV	1532-8813	162	0.369	0.012	84	3.3
ABDOM IMAGING	0942-8925	1294	1.034	0.220	118	5.5
ABH MATH SEM HAMBURG	0025-5858	281	0.150	0.000	15	>10.0
ACAD EMERG MED	1069-6563	2877	1.789	0.311	183	5.0
ACAD MED	1040-2446	4476	1.940	0.377	191	6.3
ACAD RADIOL	1076-6332	2070	1.644	0.427	171	4.2
ACCOUNTS CHEM RES	0001-4842	21293	13.141	3.414	99	6.5

4.2.5 Journal Citation Reports (JCR):

Produced by the Institute of Scientific Information (ISI)[98] is a unique resource for journal evaluation, using citation data drawn from over 8,400 scholarly and technical journals worldwide. Journals in the areas of science, technology, and social sciences are covered in JCR, and it incorporates journals from over 3,000 publishers in 60 nations. This makes JCR

[98] ISI Web of Knowlege. Retrieved August 23, 2006 from http://portal.isiknowledge.com/portal.cgi?Init=Yes&SID=Z4c6BPfcoaM4K7H5cfe.

both multi-disciplinary and international. It is important to be aware of general citation patterns when interpreting impact factors and other JCR data.

“The number of articles given to the journals listed in the JCR, include only original research and review articles. Editorials, letters, news items, and meeting abstracts are not included in article counts because they are not generally cited.

Citation frequency may vary widely for different research specialties. In some fields, five-year impact factors may be more appropriate than the two-year impact data presented in the JCR. Review articles (and review journals) tend to be cited more frequently than other types of research communications. Also, journals publishing in non-English languages or using non-Roman alphabets may be less accessible to researchers worldwide, which would influence their citation counts.”[99]

4.2.6 Impact Factor:

The Impact Factor (IF) is a measure of the frequency with which the "average article" in a journal has been cited in a particular year. The impact factor helps to evaluate a journal's relative importance, especially when comparing it to others in the same field.

The impact factor is calculated by dividing the number of current citations to articles published in the two previous years by the total number of articles published in the two previous years. For example:

Nature
Impact Factor: 29.273
Cites in 2005 to articles published in 2004 = 21496
Cites in 2005 to articles published in 2003 = 29352
Number of articles published in 2004 = 878
Number of articles published in 2003 = 1737

Cites to recent articles / Number of recent articles =
(21496 + 29352) / (878 + 1737) = 50848/2615 = 29.273

[99] National Library of Singapur. Retrieved August 23, 2006 from http://www.lib.nus.edu.sg/lion/d/jcrguide.html.

4.2.7 Journal immediacy index:

"To find out which journal's articles are cited quickly by others, JCR calculates the journal immediacy index. The immediacy index indicates how often articles published in a journal are cited within the same year."[100]

The immediacy index is calculated by dividing the number of current citations to articles published in the same year by the number of articles published in the current year. For example:

Nature
Immediacy Index: 5.825
Cites in 2005 to articles published in 2005 = 6204
Number of articles published in 2005 = 1065
Cites to current articles/Number of current articles = 6204/1065 = 5.825

"The immediacy index is useful in comparing how quickly journals are cited. Because it is a per-article average, the immediacy index tends to discount the advantage of large journals over small ones. However, frequently issued journals may have an advantage, because an article published early in the year has a better chance of being cited than one published later in the year. For comparing journals specializing in cutting-edge research, the immediacy index can provide a useful perspective."[101]

4.3 Divisions of the dissertation:

This study is divided into five sections.

4.3.1 Section one: Analysis of patent applications

The first section consists of patent applications and granted patents issued by the United States Patent and Trademark Office (USPTO), patent application in the World Intellectual property Organization (WIPO), and European Patent Office (EPO). All USPTO patents data extracted from the office of electronic information products / patent technology monitoring division. WIPO and EPO patents data were extracted from the websites of World's Intellectual Organization (http://www.wipo.int/portal/index.html.en) and European Patent Organization (http://www.epo.org/) respectively.

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[100] Library Instruction Online. Retrieved June 12, 2006 from http://www.lib.nus.edu.sg/lion/d/jcrguide.html

[101] Hot Journal and high impact journals. Retrieved August 2006 from http://www.lib.nus.edu.sg/linus/01jan/jcrimp.htm

In this section the correlation between the Gross Domestic product (GDP) and country's patent quantity is analysed. The main trend of U.S. patenting application and granted patents are presented over 40 years (1965-2005). The changes over time in the rate of patenting and the number of granted patents are exhibited.

4.3.2 Section two: Analysis of patent literature in MEDLINE

The second section analysis the patent literature in MEDLINE (both in PubMed [102] and ERL[103]). In this section a Scientometric analysis is performed to assess the quantitative trend of patent literature in MEDLINE throughout 1965-2005. The kind of languages, publication type, journals, and the origin of published documents are presented.

4.3.3 Section three: Analysis of patent literature in the SCI

The third section analysis the patent literature in the Science Citation Index. In this section all documents indexed as "patents" topic (in the Field Tags) in the SCI throughout 1965-2005 are analysed. In this section the publication pattern concerning, origin of patents, citation frequency, document types, the language of publication, distribution of journals, and the most frequently patent citing authors are performed.

4.3.4 Section four: Analysis of citations to the patent documents

The fourth section analysis the patent-citing documents (patents cited in the references of documents) indexed in the Science Citation Index, with illustrating the number of references per paper and comparing them with the general scientific documents. References to patents are identified through patent numbers that appear instead of the first authors name in the reference search of the cited author / field. The half-life of patent documents and general scientific documents are defined. The growth of the mean value for the number of cited references per documents in the SCI is illustrated.

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[102]PubMed is a service of the National Library of Medicine that includes over 16 million citations from MEDLINE and other life science journals for biomedical articles back to the 1950s. PubMed links to full text articles and other related resources.

[103] ERL (Electronic Reference Library) is a multi-user application server implementation of SilverPlatter's Core Technology.

4.3.5 Section five: Analysis of cited references per paper in the SCI

The fifth section analysis the references per paper in the SCI through 1970-2005. To achieve this aim a total number of 10,000 records for each year were randomly chosen and the mean value of cited references per paper was calculated. The IF of all journals indexed in the JCR throughout 1999-2005 was extracted and their mean value calculated in order to compare with the trend of references per paper in the SCI. All data extracted from the annual volumes of the CD-Edition of Science Citation Index (SCI) and the Web of Science of the Institute for Scientific Information (ISI), the journal citation and self-citation data extracted from the JCR, the self-citing rate and self-cited rate calculated based on the JCR method (The self-citing rate is the percentage of journal self-citations divided by the total number of citations (cited references) that appeared in the journal during a given period of time. The self-cited rate is the percentage of journal self-citations divided by the total number of citations the journal received during a given period of time).

5 Section one: Patent applications

This section consists of patent applications and granted patents issued by the United States Patent and Trademark Office (USPTO), patent application in the World Intellectual property Organization (WIPO), and European Patent Office (EPO).

In this section the relationship between the Gross Domestic product (GDP) and country's patent quantity is analysed.

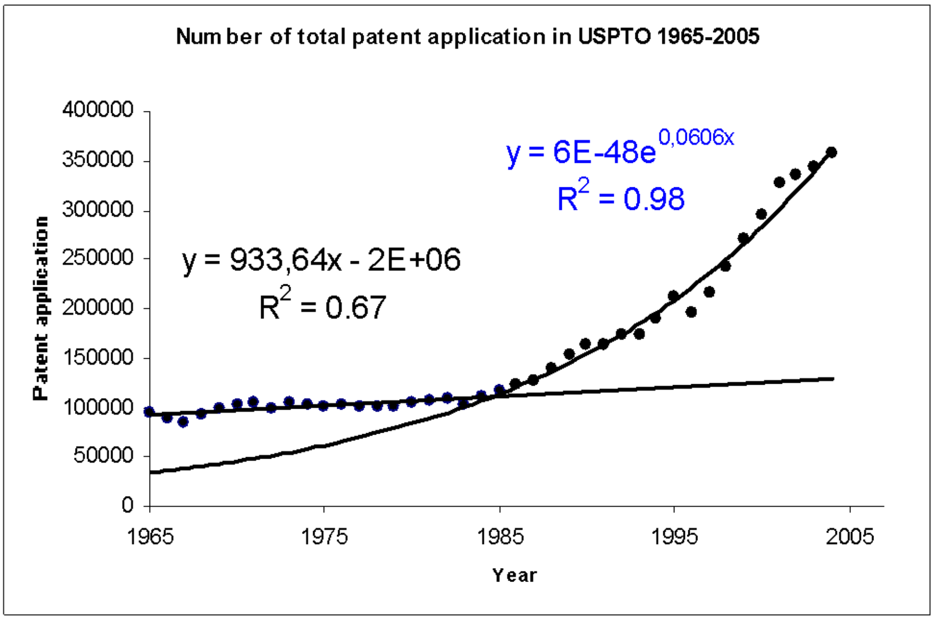


Figure 1: Number of total patent application (utility patent) filed in the United States patents and Trademark Office 1965-2005[104].

Figure 1 shows the number of patent applications in the United State and Trademark office through 1965-2005 by entire world (all countries + the USA). It is considerable that annual number of patent applications by entire world show unremarkable growth during 1965 and 1985. In other words it seems remaining roughly constant up to 1985, oscillating around 1996, and then takes off exponentially, the peak emerges in 2004.

Accurately it can be dividing in 2 stages:

- Stage A (1965-1985): In this stage the number of patent application is roughly constant in spite of some fluctuation throughout the period.
- Stage B (1986-2005): This stage indicates that the number of patent application through 1986-2005 has increased exponentially with a doubling time of 11.4 years.

As stage A shows, the growth of patent application throughout 1965-1985 is very slight. Figure shows an increase of +933 applications per year.

The Figure indicates that there is a linear correlation between the number of patent application and the year of under study with a regression coefficient R = 0.82.

[104]U.S. Patent and Trademark Office, Office of Electronic Information Products / Patent Technology Monitoring Division. Retrieved January 20, 2006 from http://www.uspto.gov/go/taf/us_stat.pdf.

Stage B shows, the number of patent application throughout 1986-2005 took off exponentially with a doubling time of 11.4 years. The formula $R^2 = 0.98$ indicates that the correlation between the years and the number of patent application in the USPTO is very high ($R = 0.99$).

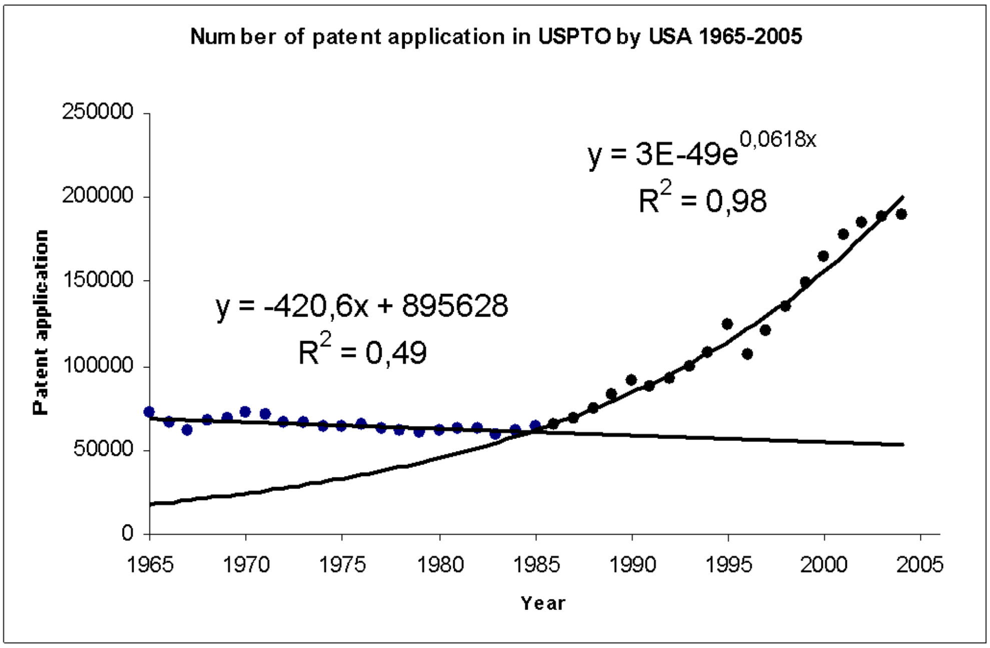


Figure 2: Number of patent application in USPTO by the U.S.A 1965-2005.

Figure 2 illustrates the annual number of patent applications filed in USPTO by United States.[105] Apparently the Figure shows that the number of patent applications in USPTO by USA similar to the patent applications in USPTO (Figure 1) by all the countries (entire world) remained constant up to 1985, but the fact is that the number of patent applications throughout 1965-1985 shows a decrease about -420 applications per year during this period, but since 1986 it takes off exponentially, reaching almost 170,000 by the end of twentieth-century. It is remarkable that since 1995 the number of patent applications by the USA likewise by the entire world shows a sharp increase. Accurately the Figure can be divided in two stages:

- Stage A (1965-1985)
- Stage B (1986-2005)

---

[105]U.S. Patent and Trademark Office, Office of Electronic Information Products, Patent Technology Monitoring Division (PTMD). Retrieved January 20, 2006 from http://www.uspto.gov/go/taf/us_stat.pdf.

Stage A shows that the number of patent applications throughout 1965-1985 encounters a decrease of about 420 applications per year. Stage B shows an exponentially increase throughout 1986-2005 with a doubling time of 11.2 years. The number of patent applications in 2004 is three (3) times higher than patent application in 1984.

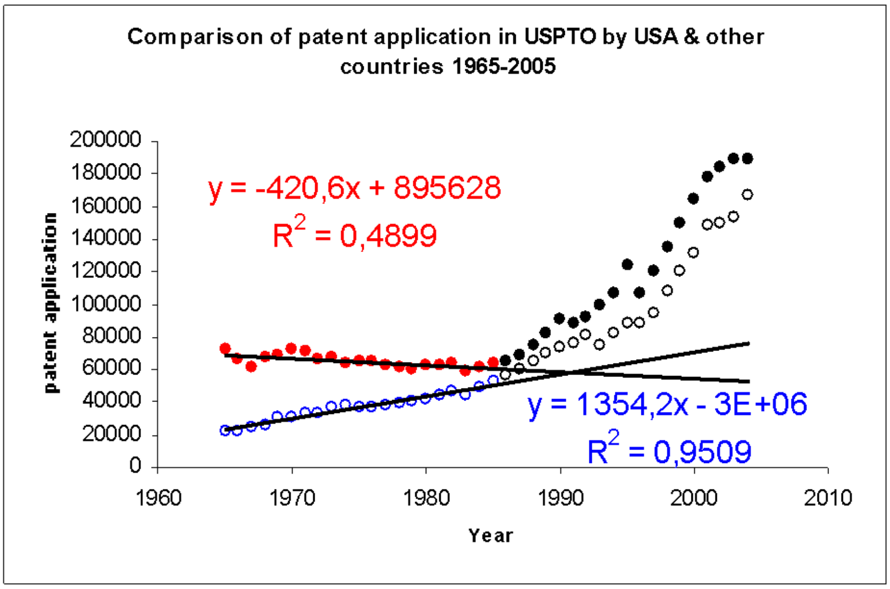


Figure 3: Comparison of patent application in USPTO by the USA (full circles) with other countries (open circle) 1965-2005

Figure 3 illustrates the number of patent applications in USPTO by USA (full circles) and the number of patent applications by other countries (all exclude USA) from 1965 to 2005 (blank circles). From 1965 to 1985 the number of patent applications by the USA show relatively slight decrease, but the number of patent applications by other countries (all countries minus USA) during this period show slight increase. Both of them are characterized by an exponential increase since 1986.

The USA must be considered as being outstanding, with the highest amount of patents filed in the USPTO. 58% of all filed patents in the USPTO throughout 1965-2005 belong to the USA.

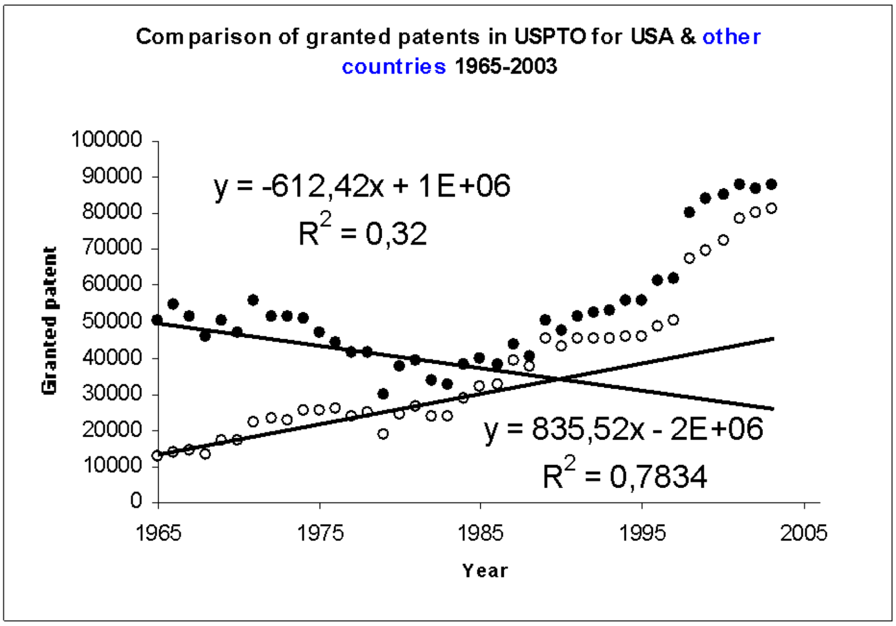


Figure 4: Comparison of granted patents issued by USPTO for U.S.A (●) and all other countries (○) 1963-2003.[106]

Figure 4 shows the number of granted patents for the USA (full circles) and all other countries in the world (blank circles) in the USPTO through 1963-2003. As Figure illustrates from 1963 to 1985 the number of granted patents for the U.S.A. shows a decrease of 612 applications yearly, but the number of granted patents for other countries shows a roughly increase. It means the growth of patents granting in other countries through 1965-1985 are higher than the U.S.A. although the number of granted patents for the U.S.A. stayed higher than other countries. The number of granted patent from 1986 shows an exponential increase for entire world (all countries) as well as the U.S.A.

[106] Patent technology division. Retrieved January 20, 2006 from http://www.uspto.gov/web/offices/ac/ido/oeip/taf/h_at.htm#PartA1_1

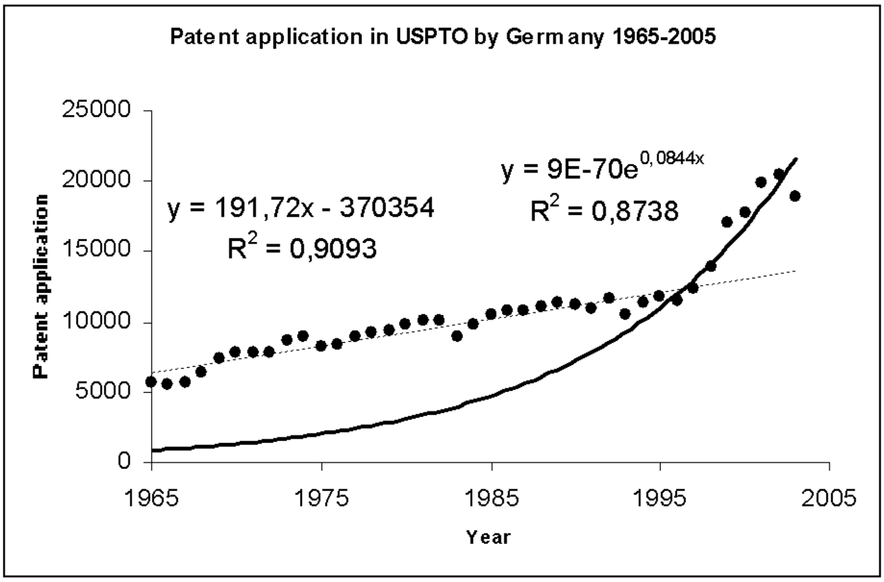


Figure 5: Number of patent application issued by USPTO for Germany 1963-2003

As Figure 5 shows, the number of patent application for Germany from 1965 to 1996 has a slight growth (+192 per year). Since 1997 the number of patent application by Germany shows an exponential increase. This increase is simultaneous with the boom of patent applications in USPTO.

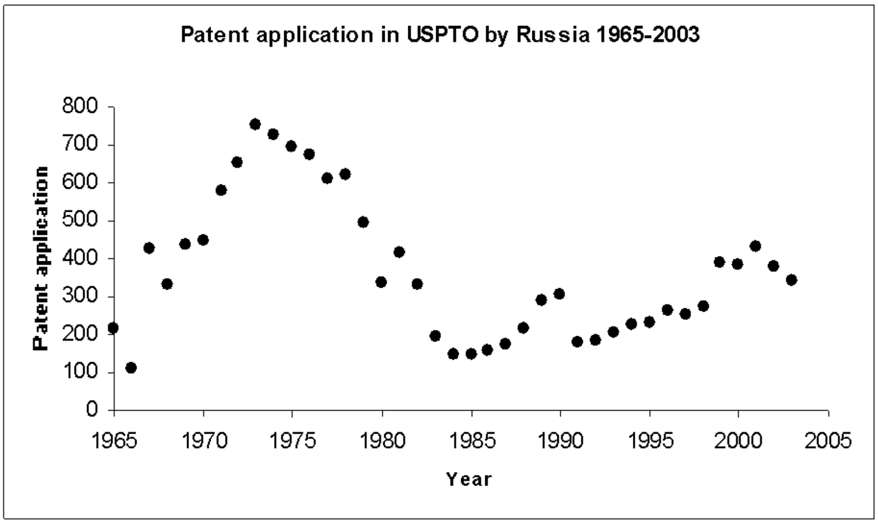


Figure 6: Number of patent application in USPTO by Russia 1963-2003.[107]

As Figure 6 shows, the most patent applications by Russia came before 1980 (1970-1980).

[107] U.S. Patent and Trademark Office, office of electronic information products, patent technology monitoring division (PTMD). Retrieved January 20, 2006 from http://www.uspto.gov/web/offices/ac/ido/oeip/taf/h_at.htm#PartA1_1

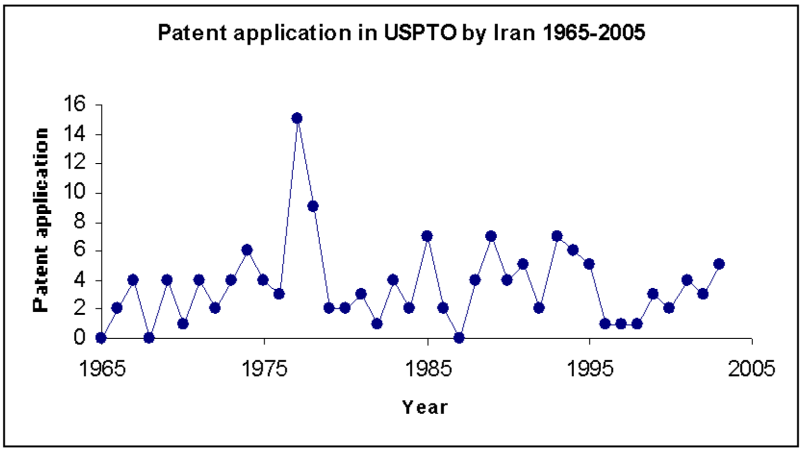


Figure 7: Number of patent application issued by USPTO for Iran 1963-2003

As Figure 7 shows, patent application for Iran doesn't have significant rate, the peak emerges in 1977 before a fall down in 1979. Most presumably this fall was due to the socio-political condition of the country at that time, because it was simultaneous with the revolution of Iran in 1979.

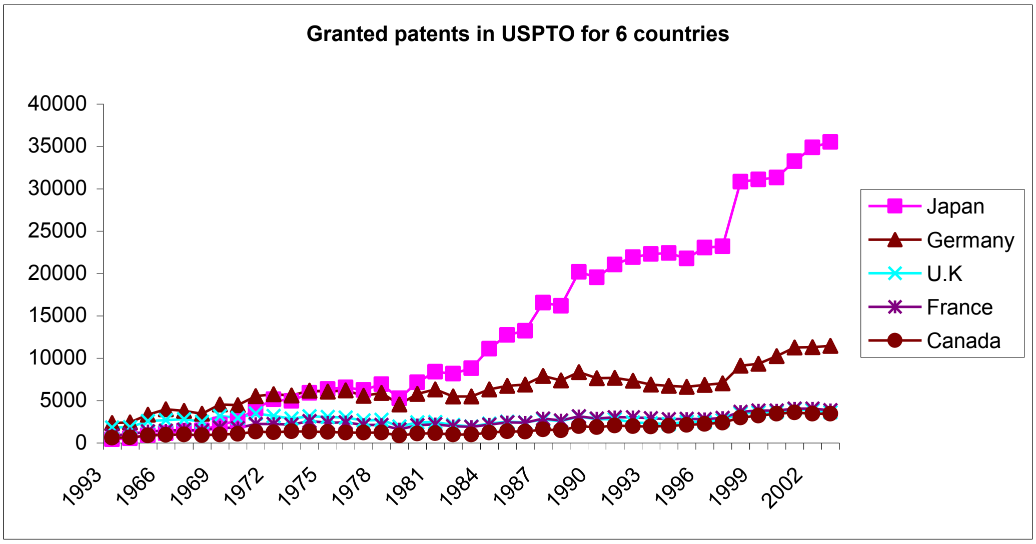


Figure 8: Number of granted patent issued by USPTO for Japan, Germany, U.K., France and Canada 1963-2005.[108]

As Figure 8 shows, the growth of granted patents issued for France and Canada until 1997 shows slight increase. The number of granted patents for Germany from 1963 to 1996 shows slight increase, but since 1997 shows a relatively high growth.

[108]USPTO. Retrieved January 20, 2006 from http://www.uspto.gov/web/offices/ac/ido/oeip/taf/h_at.htm#PartA1_1

Japan enjoys a sharp increase in the term of granted patents from 1984 peaking in 2003.

In comparison the rate of granted patens among these six countries, indicates that before 1975 patent application by Germany was higher than the others, but from 1980 the patent application by Japan increased rapidly and paced ahead of Germany.

All the countries enjoy relatively increase since 1999 to 2003. There is a slight decrease for all countries in 2004 and 2005.

Table 1: Distribution of granted patent in origin country throughout 1965-2005[109]

rank	Origin of granted patents	No. of granted patent throughout (1965-2005)
1	U.S.A.	2,215,842
2	JAPAN	621,070
3	GERMANY	280,349
4	U.K.	116,121
5	FRANCE	105,542
6	CANADA	72,768
7	TAIWAN	51,802
8	SWITZERLAND	49,666
9	ITALY	41,555
10	SOUTH KOREA	38,214
11	SWEDEN	36,458
12	NETHERLANDS	33,559
13	AUSTRALIA	16,442

[109] U.S. patent and Trademark Office, Electronic Information products Division, patent Technology Monitoring Branch (PTMB). Retrieved January 20, 2006 from http://www.uspto.gov/web/offices/ac/ido/oeip/taf/h_at.htm#PartA1_1

14	BELGIUM	14,644
15	AUSTRIA	13,301
16	ISRAEL	13,270
17	FINLAND	11,619
18	DENMARK	8,988
19	U.S.S.R.	6,966
20	SPAIN	5,244
21	NORWAY	4,997
22	SOUTH AFRICA	3,627
23	SINGAPORE	2,893
24	CHINA,HONG KONG S.A.R.	2,837
25	HUNGARY	2,676
26	CHINA P.REP.	2,510
27	INDIA	2,407
28	MEXICO	2,168
29	NEW ZEALAND	2,217
30	CZECHOSLOVAKIA	2,062
31	IRELAND	2,007
32	RUSSIAN FEDERATION	1,873
33	BRAZIL	1,755
34	ARGENTINA	1,096
35	LUXEMBOURG	870
36	POLAND	778

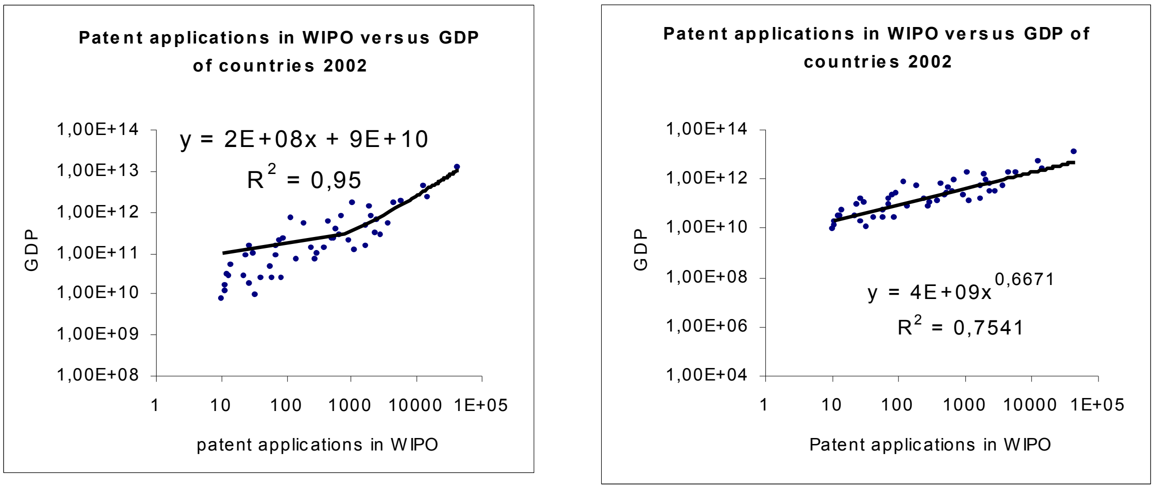
37	VENEZUELA	637
38	Others (133)	8,017

Table 1 shows the rank of countries in filing and granting patents. As table illustrates the most majority of granted patent issued by USPTO belong to the USA (58%). The USA is the leading country filing and granting patents followed by Japan and Germany respectively.

The portion of entire countries (all countries excluded the USA) is only 42%.

The origin country of an application is based on the residence of the first-named inventor.

If we calculate the granted patent by USSR and Russia together, then Russia gets the fifth rank in the table.



a b

Figure 9: Patent application in WIPO (PCT) versus GDP of 49 more productive countries[110]

The X axis shows the number of patent application in the year 2002, and the Y axis shows the amount of GDP for countries in the year 2002, only the countries, those applied for more than 10 patents in WIPO in the fiscal year 2002 were taken under consideration.

As Figure 9a shows, there is a linear correlation between the GDP of countries and the number of patents application in WIPO with a correlation coefficient R = 0.973. It is evident

[110] Yearly Review of the PCT 2002. Retrieved January 20, 2006 from http://www.wipo.int/pct/en/activity/pct_2002.pdf

that most of the points below ~500 patent applications per country are beneath the regression line. The cause for this bias is very simple. Low values have much smaller square values than GDP values in the range of 10^{12} \$. In so far it is sensible to choose the better fitting power law in Figure 9b. The costs for patents of more productive 49 countries were calculated in relation to their GDP. The average costs of a patent in WIPO sum up about to 264 million US\$.

As Figure 9b illustrates, the scattering of points on the regression line is more appropriate than Figure 9a (the linear method). The Figure shows a correlation coefficient of R = 0.868.

The formula "$y = 4E{+}09x^{0.6671}$" indicates that if there is a patent application in WIPO per country in the fiscal year 2002, then GDP is \$4 10^9. The USA with 44,609 patent applications should need only \$ 5.05 10^{12}, but the real value in 2002 was 207% higher (\$ 1.05 10^{13}).

Table 2 shows the number of patent application (PCT) in WIPO and the amount of GDP for 49 more productive countries in 2002, and the percent deviation of GDP from the expected rate. The countries, those applied for more than 10 applications for patent in WIPO were taken into consideration.

Table 2 indicates that the GDP per patent application in the USA is 207% higher than the expected rate. GDP per patent application in Japan is 172% higher than the expected rate, in China 335%, in France 127% and in UK is 115% higher than the expected rate. It is considerable that the expected rate for Germany is 82% lower than the real GDP in 2002. The presumptions that the real GDP in a country is greater than the expected rate:

1. Expensive researches have been donning in the country e.g. the USA
2. There has been little research activity in the country e.g. Romania, Czech Republic, Cuba and Kazakhstan.

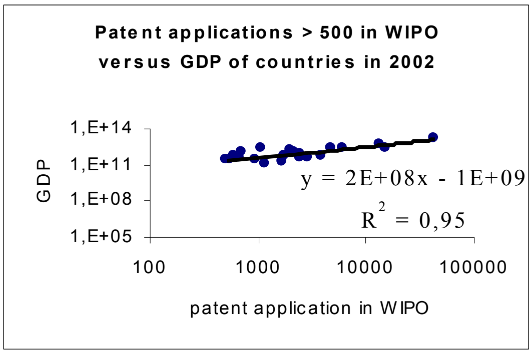
Table 2: Number of patent application, GDP, and the percent of deviation from the expected rate of GDP for 49 more productive countries in WIPO (PCT) 2002

No,	Country	No. of patent application in WIPO (PCT) 2002	GDP of country in million US$	Expected GDP of country in million US$	% Deviation
1	USA	44,609	10,469,600	5,054,634	207%
2	Germany	15,269	2,025,798	2,472,180	-82%
3	Japan	13,531	3,911,581	2,280,711	172%
4	UK	6,274	1,574,003	1,365,847	115%
5	France	4,877	1,464,204	1,154,587	127%
6	Netherlands	4,019	439,357	1,014,769	-43%
7	Sweden	2,988	244,314	832,696	-29%
8	Republic of Korea	2,552	546,935	749,532	-73%
9	Switzerland and Liechtenstein	2,469	277,113	733,180	-38%
10	Canada	2,210	735,601	680,933	108%
11	Italy	2,041	1,223,272	645,738	189%
12	Australia	1,775	413,570	588,302	-70%
13	Finland	1,762	133,024	585,424	-23%
14	Israel	1,199	104,266	452,835	-23%
15	China	1,124	1,453,837	433,737	335%
16	Denmark	989	174,420	398,250	-44%
17	Spain	729	688,501	324,927	212%

18	Belgium	697	252,721	315,341	-80%
19	Russia	616	345,071	290,395	119%
20	Austria	563	208,422	273,479	-76%
21	Norway	525	191,514	261,023	-73%
22	India	480	493,335	245,876	201%
23	South Africa	407	111,138	220,252	-50%
24	Singapore	322	88,468	188,387	-47%
25	New Zealand	301	59,765	180,099	-33%
26	Ireland	257	123,261	162,079	-76%
27	Brazil	204	460,612	138,936	332%
28	Hungary	148	65,562	112,161	-58%
29	Mexico	128	649,078	101,807	638%
30	Poland	98	198,039	85,194	232%
31	Luxembourg	91	21,538	81,084	-27%
32	Turkey	86	182,973	78,084	234%
33	Greece	74	134,456	70,636	190%
34	Czech Republic	74	73,756	70,636	104%
35	Croatia	63	22,798	63,445	-36%
36	Ukraine	61	42,393	62,095	-68%
37	Slovenia	44	22,292	49,935	-45%
38	Iceland	35	8,768	42,865	-20%
39	Colombia	33	81,122	41,216	197%
40	Portugal	29	127,906	37,812	338%
41	Bulgaria	29	15,614	37,812	-41%

42	Philippines	26	76,814	35,155	219%
43	Slovakia	24	24,239	33,327	-73%
44	Romania	15	45,825	24,357	188%
45	Kazakhstan	14	24,599	23,262	106%
46	Cuba	13	25,900	22,140	117%
47	Belarus	12	14,654	20,989	-70%
48	Cyprus	12	10,467	20,989	-50%
49	Estonia	11	7,038	19,805	-36%

The estimated rate of GDP for countries was calculated based on the correlation coefficient of regression in the form of power law. The percentage deviation of GDP from the real GDP of countries was calculated as: $\dfrac{\text{GDP of country in million US \$}}{\text{Expected rate of GDP for country in million US \$}}$



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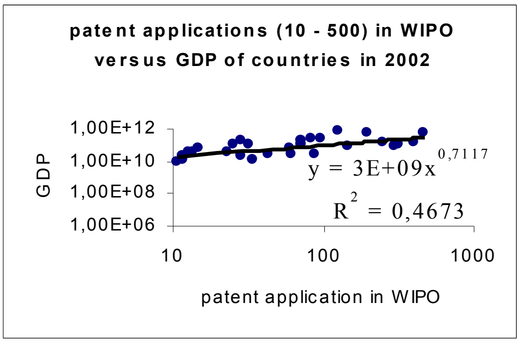

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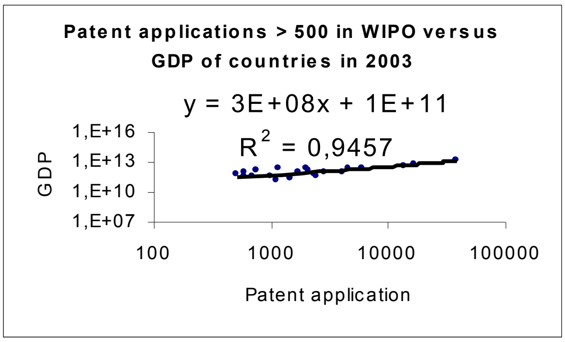
Figure 10: Patent applications higher than 500 (a), patent applications less than 500 (b) in WIPO versus GDP of countries in 2002.

Figure 10a shows the number of patent applications in WIPO versus GDP of countries, those applied for more than 500 patents in 2002. Figure 10b shows the number of patent applications versus GDP of countries; those applied for less than 500 applications in 2002.

As Figure 10a indicates there is a linear correlation between the GDP of countries and the number of patent application with a correlation coefficient of R = 0.973.

Figure 10b indicates that, there is a power law correlation between the patent application in WIPO (the countries, those applied for less than 500 applications annual), and the GDP of countries in 2002. The regression shows a correlation coefficient of R = 0.684.



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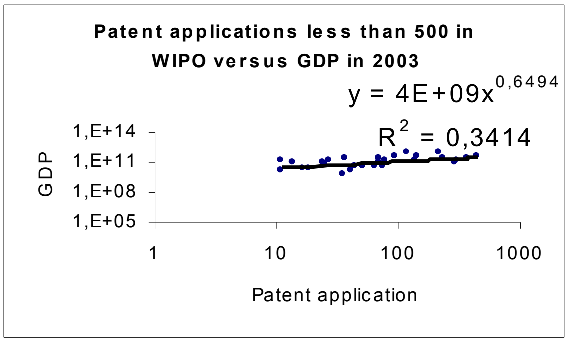

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Figure 11: Patent application higher than 500 (a), patent application less than 500 (b) in WIPO versus GDP of countries in 2003.

Figure 11a shows the number of patent applications in WIPO versus GDP of countries, those applied for more than 500 patents in 2003. The Figure 11b shows the number of patent applications versus GDP of countries; those applied for less than 500 patents in 2003.

As Figure 11a indicates, there is a linear correlation between GDP of countries and the number of patent application in WIPO in 2003. The regression shows a correlation coefficient of R = 0.97.

Figure 11b shows the number of patent application versus GDP of countries, those their applications were between 10 and 500 in 2003. There is a power law correlation between the number of patent application in WIPO and GDP of countries with a correlation coefficient of R = 0.584).

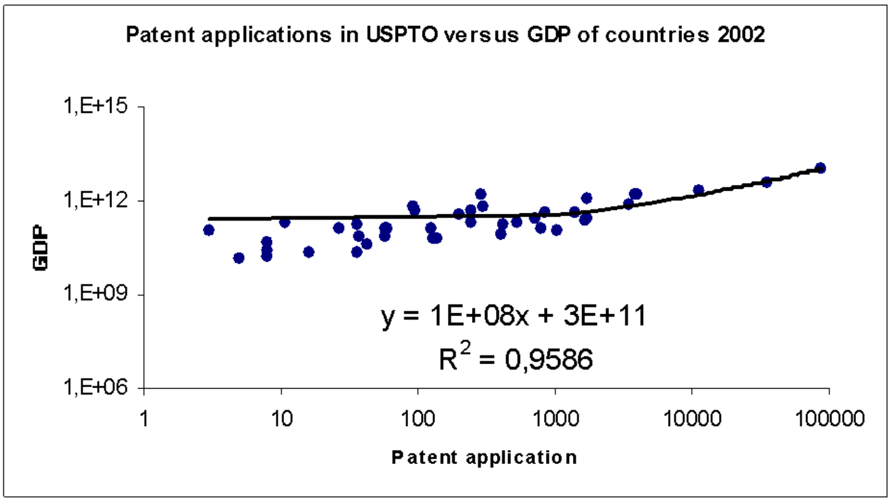


Figure 12: Patent application in USPTO versus GDP of 42 countries in 2002

Figure 12 shows the number of patent applications in USPTO versus GDP of 42 more productive countries in 2002. There is a linear correlation between the GDP and the amount of patent applications of countries in the USPTO. The formula "$R^2 = 0.9586$" indicates that, the correlation coefficient between the patent application in the USPTO and the amount of GDP is very high (R = 0.979). The richer a country is in term of GDP, the more applied for patents in the USPTO. It is evident that most of the countries with lower applications are beneath the regression line. It seems more logical to choose the better fitting power law in Figure 13.

The average costs of a patent in the USPTO sum up to 115million US$.

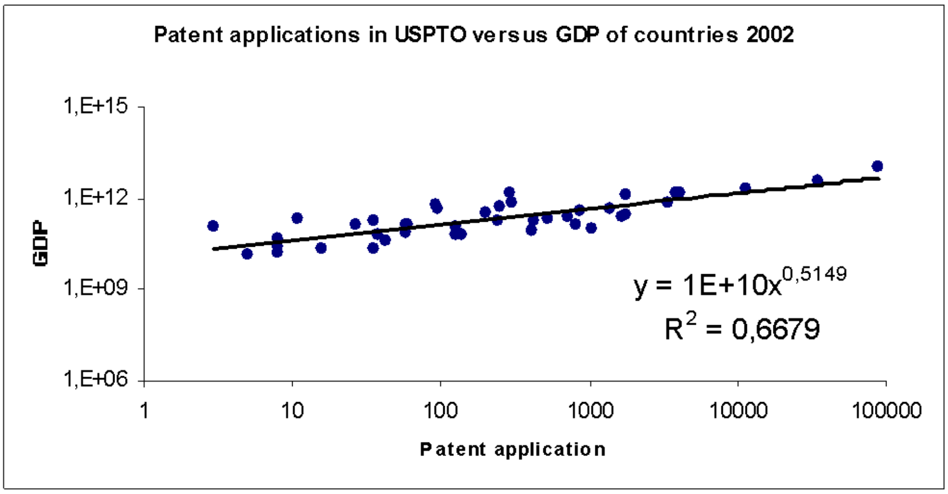


Figure 13: Patent application in USPTO versus GDP of 42 countries in 2002

Figure 13 shows the number of patent applications in USPTO versus GDP of 42 more productive countries in 2002 with a power law correlation. The Figure indicates that there is a power law correlation between the GDP and the amount of patent applications of countries in the USPTO. The correlation coefficient is R = 0.82.

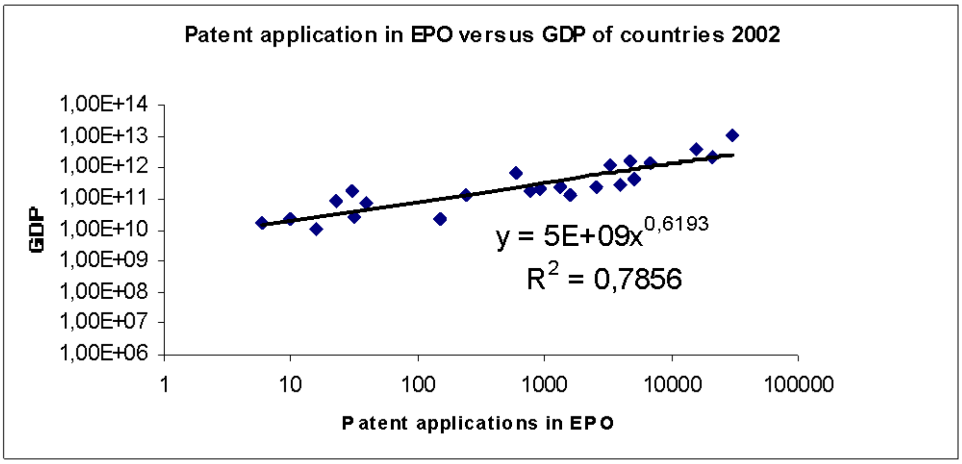


Figure 14: Patent application in EPO versus GDP of countries in 2002

As Figure 14 shows, there is a power law correlation between the number of patent application in European patent Organization (EPO) and the amount of GDP. One can say that, the more the country richer is, the more applications has applied for patents to EPO.

The correlation coefficient is high, it indicates that the relation between the number of patent application in the EPO and the amount of GDP is strong. The formula "$y = 5E+09x^{0.6193}$" indicates that if there is only one patent per country in EPO, then GDP is \$5 10^9 The average costs of a patent in the EPO sum up to 238 million US\$.

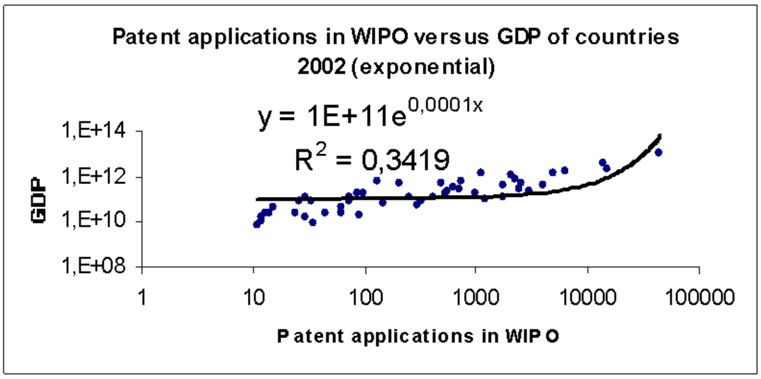
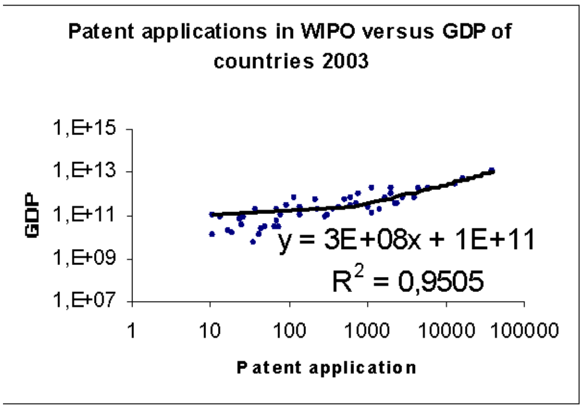


Figure 15: Patent application in the WIPO versus the GDP of countries in 2002 (Exponential method)

As Figure 15 indicates, the exponential regression doesn't show a suitable correlation. The correlation coefficient is low.

In order to explore whether the relationship between the amount of GDP and the productivity of countries is a common phenomenon; patent application of most productive countries (those their paten application was more than 10 times in the WIPO) in 2003, 2004 and 2005 was analysed, likewise in 2002. The obtained results are as follow:



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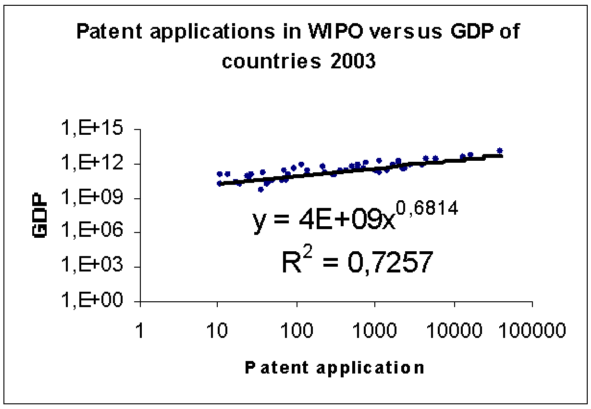

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Figure 16: Patent applications in WIPO versus GDP of countries in 2003. Countries those applied for more than 10 patents were taken into consideration (a = linear, b = power law)

Figure 16a indicates that there is a linear correlation between the amount of GDP in the countries and the number of patents application in the WIPO. The correlation coefficient is very high (R = 0.974). It indicates that the amount of GDP in countries is an important factor in the creation of innovations. It is evident that most of the countries with lower applications are beneath the regression line. It seems more logical to choose the better fitting power law in Figure 16b. Figure 16b shows that there is a power law correlation between the number of patent applications in WIPO and GDP of countries with a correlation coefficient of R = 0.85.

Table 3: Number of patent application in WIPO (PCT), GDP, estimated GDP, and percent of countries GDP from estimated rate in 2003 for 49 more productive countries

No.	Country	Patent application in WIPO 2003	GDP in million US$	Estimated GDP in million US$	% Deviation
1	USA	39,250	10,971,250	5,398,863	203%
2	Japan	16,774	4,237,073	3,025,014	140%
3	Germany	13,979	2,446,432	2,671,698	-92%
4	UK	6,090	1,807,485	1,516,695	119%
5	France	4,723	1,794,389	1,275,475	141%
6	Netherlands	4,180	538,669	1,173,625	-46%
7	Korea	2,974	608,146	930,667	-65%
8	Sweden	2,491	304,854	824,801	-37%
9	Switzerland	2,379	322,915	799,347	-40%
10	Canada	2,102	870,477	734,686	118%
11	Italy	2,023	1,511,141	715,757	211%
12	Australia	1,729	527,042	643,122	-82%
13	Finland	1,497	162,621	582,983	-28%
14	China	1,205	1,640,966	502,857	326%
15	Isreal	1,161	110,457	490,272	-23%
16	Denmark	1,021	214,269	449,169	-48%
17	Spain	776	882,667	372,573	237%
18	Belgium	725	310,521	355,709	-87%
19	Austria	620	256,662	319,739	-80%
20	India	611	575,330	316,569	182%

21	Russia	527	431,429	286,221	151%
22	Norway	448	222,892	256,236	-87%
23	South Africa	376	166,170	227,401	-73%
24	Singapore	313	92,727	200,689	-46%
25	New Zealand	296	79,265	193,196	-41%
26	Ireland	237	157,295	166,040	-95%
27	Braziel	221	505,535	158,317	319%
28	Poland	144	216,539	118,241	183%
29	Hungary	141	83,100	116,557	-71%
30	Mexico	123	639,109	106,199	602%
31	Turkey	98	240,596	90,966	264%
32	Czech Republic	79	90,602	78,542	115%
33	Croatia	76	28,812	76,497	-38%
34	Greece	71	174,320	73,031	239%
35	Ukraine	70	50,133	72,329	-69%
36	Slovenia	66	28,069	69,486	-40%
37	Luxembourg	52	27,090	59,067	-46%
38	Bulgaria	46	19,974	54,333	-37%
39	Iceland	42	10,802	51,067	-21%
40	Portugal	38	155,515	47,701	326%
41	Yugoslavia	36	4,583	45,975	-10%
42	Colombia	28	79,459	38,739	205%
43	Slovakia	26	32,665	36,832	-89%
44	Romania	25	59,506	35,860	166%

45	Cyprus	19	13,191	29,744	-44%
46	Belarus	17	17,823	27,573	-65%
47	Philippines	14	79,202	24,156	328%
48	Egypt	11	81,384	20,496	397%
49	Latvia	11	11,186	20,496	-55%

Countries, those applied for more than 10 patents in WIPO in 2003, were taken into consideration. Table 3 indicates that the GDP per patent application in the USA is 203% higher than the expected rate.

GDP per patent application in Japan is 140% higher than the expected rate, in China 326%, in France 141% and in UK is 119% higher than the expected rate. It is considerable that the expected rate for Germany is 92% lower than the real GDP in 2003.

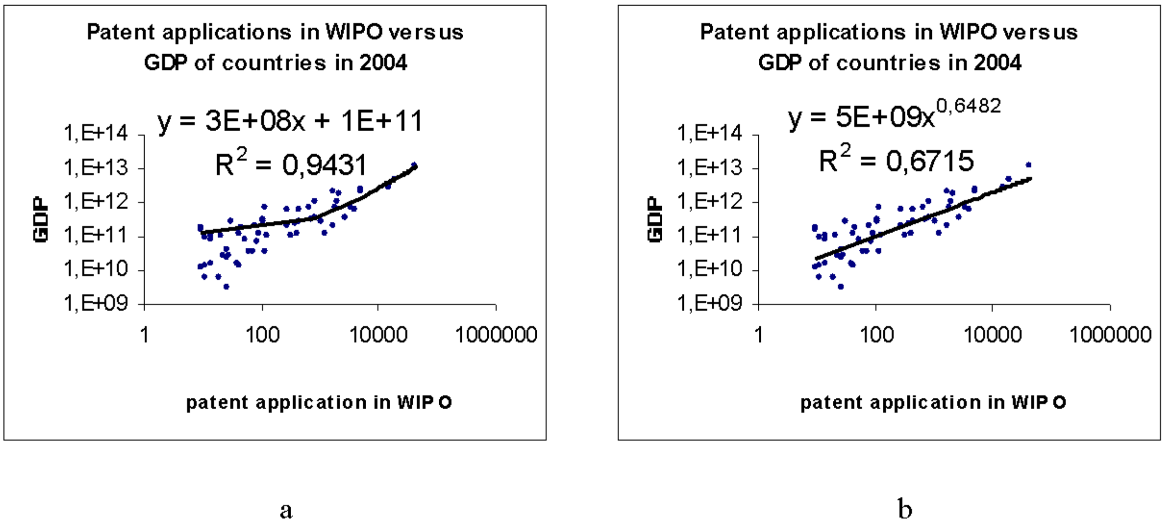


Figure 17: Patents applications in WIPO versus GDP of 59 more productive countries in 2004

Figure 17a shows that there is a linear correlation between the number of patent applications in WIPO and GDP of 59 countries in 2004. It is evident that most of the countries with lower applications are beneath the regression line. It seems more logical to choose the better fitting power law in Figure 17b.

Figure 17b shows that there is a power law correlation with a correlation coefficient of R = 0.82 between the amount of GDP in countries and the number of patents application in WIPO.

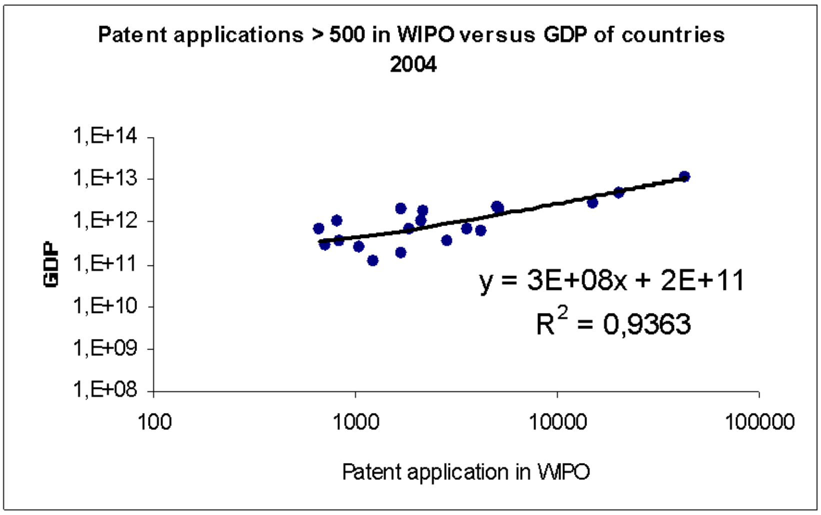


Figure 18: Patent applications > 500 in WIPO versus GDP of countries in 2004

Figure 18 shows that there is a linear correlation between patent applications in WIPO and GDP of countries, those applied for more than 500 patents in 2004. The regression shows that the correlation coefficient is R = 0.97.

Table 4: No. of patent application in WIPO, GDP, estimated GDP, and percent of deviation from estimated GDP for 59 more productive countries in 2004

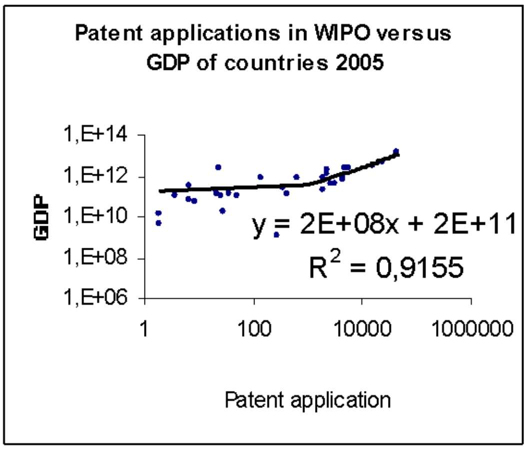
No	Country	Patent application in WIPO 2004	GDP in US$ Million	estimated GDP in US$ million	% Deviation
1	USA	42,713	11,734,300	5,017,635	234%
2	Japan	20,167	4,587,070	3,084,882	149%
3	Germany	15,214	2,754,727	2,569,805	107%
4	France	5,115	2,045,581	1,267,780	161%
5	UK	5,039	2,133,206	1,255,537	170%
6	Netherlands	4,196	607,531	1,115,044	-54%
7	Republic of Korea	3,553	679,675	1,001,073	-68%

8	Switzerland	2,837	359,042	865,194	-41%
9	Sweden	2,831	350,664	864,007	-41%
10	Italy	2,189	1,724,953	731,337	236%
11	Canada	2,107	993,443	713,460	139%
12	Australia	1,846	637,472	654,849	-97%
13	China	1,704	1,931,642	621,740	311%
14	Finland	1,676	186,154	615,098	-30%
15	Israel	1,229	116,905	503,057	-23%
16	Denmark	1,050	245,172	454,260	-54%
17	Belgium	831	357,447	390,351	-92%
18	Spain	823	1,041,038	387,911	268%
19	Austria	713	294,711	353,462	-83%
20	India	667	665,867	338,508	197%
21	Russian	472	590,705	270,532	218%
22	Norway	466	255,106	268,298	-95%
23	Singapore	423	107,502	251,979	-43%
24	South Africa	401	214,989	243,404	-88%
25	New Zealand	342	97,874	219,546	-45%
26	Ireland	296	184,700	199,922	-92%
27	Brazil	278	603,783	191,955	315%
28	Hungary	135	100,742	120,186	-84%
29	Luxembourg	120	31,908	111,351	-29%
30	Mexico	118	683,486	110,145	621%
31	Turkey	114	302,561	107,710	281%

32	Poland	107	252,369	103,375	244%
33	Czech Republic	94	107,694	95,050	113%
34	Ukraine	87	65,039	90,400	-72%
35	Greece	78	207,842	84,222	247%
36	Croatia	76	34,309	82,816	-41%
37	Slovenia	62	32,494	72,577	-45%
38	Egypt	53	78,753	65,561	120%
39	Portugal	48	177,598	61,482	289%
40	Malaysia	45	118,318	58,963	201%
41	Iceland	42	13,084	56,385	-23%
42	Cyprus	39	15,501	53,740	-29%
43	Saudi Arabia	32	250,892	47,272	531%
44	Serbia and Montenegro	29	24,353	44,350	-55%
45	Belarus	27	23,141	42,343	-55%
46	Slovakia	26	41,091	41,320	-99%
47	Barbados	26	2,845	41,320	-7%
48	Bulgaria	24	24,331	39,230	-62%
49	Colombia	22	96,788	37,079	261%
50	Bahamas	20	5,711	34,858	-16%
51	United Arab Emirates	15	104,204	28,928	360%
52	Romania	14	75,487	27,662	273%
53	Panama	14	14,204	27,662	-51%
54	Philippines	11	86,123	23,659	364%

55	Latvia	11	13,723	23,659	-58%
56	Mauritius	11	5,919	23,659	-25%
57	Thailand	10	161,688	22,242	727%
58	Argentina	10	151,958	22,242	683%
59	Estonia	10	11,229	22,242	-50%

As table 4 indicates, GDP per patent application in WIPO for the USA is 234% higher than the expected rate. GDP per patent application in Japan is 149% higher than the expected rate, in China 311%, in France 161% and in UK is 170%, and in Germany 107% higher than the expected rate.



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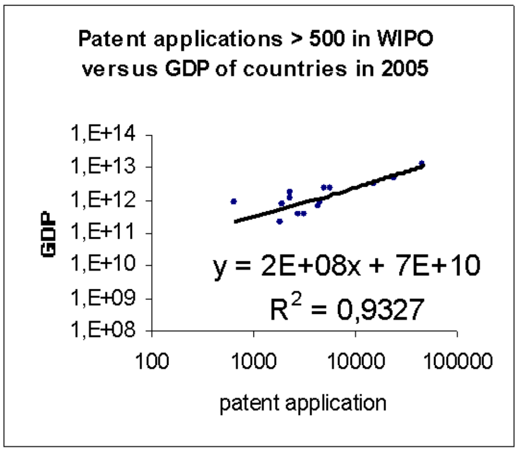

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Figure 19: Patent applications in WIPO (PCT) versus GDP of countries in 2005 (a), patent applications >500 (b) in WIPO versus GDP of countries 2005

Figure 19a shows the number of patent applications in WIPO versus GDP of 31 more productive countries in 2005. Figure 19b shows the number of patent applications greater than 500 versus GDP of 14 countries in 2005. As Figure 19a illustrates there is a linear correlation between the amount of GDP in countries and the number of patent applications in the countries. The correlation coefficient is R = 0.95. It is evident that most of the points below ~500 patent applications per country are beneath the regression line. If we take only the countries under consideration which applied for equal or above 500 patents, then this Figure shows that, they are more converge to the regression line (linear regression (19b) with a correlation coefficient of R = 0.965) as compare to the whole list of the patents in 2005 which is shown in Figure 19a.

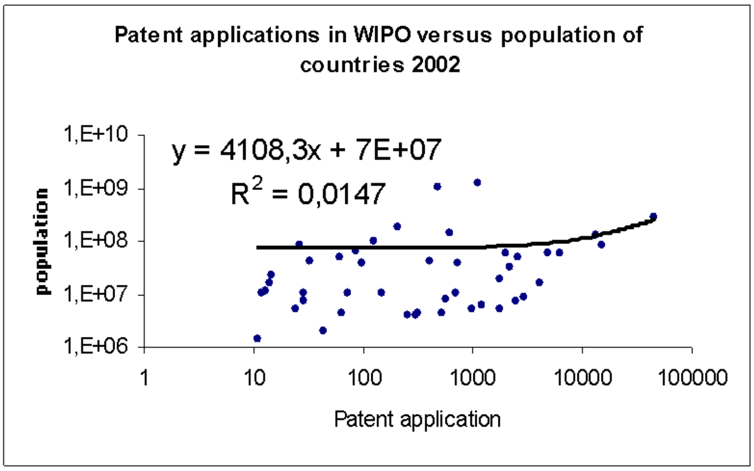

Figure 20: Patent applications in WIPO (PCT) versus the population of 49 more productive countries in 2002 in linear method

Figure 20 shows the correlation between the numbers of patent application in WIPO versus population of 49 more productive countries in 2002. As Figure illustrates there is a weak correlation between the size of population in the countries and the amount of patents application in WIPO. The correlation coefficient is low (R^2 = 0.0147).

The Figure shows that though the population of a country is large, the number of patent applications shows no growth. The reason is clear. Wealth in a country is requirement of research activities and also more important than the size of population.

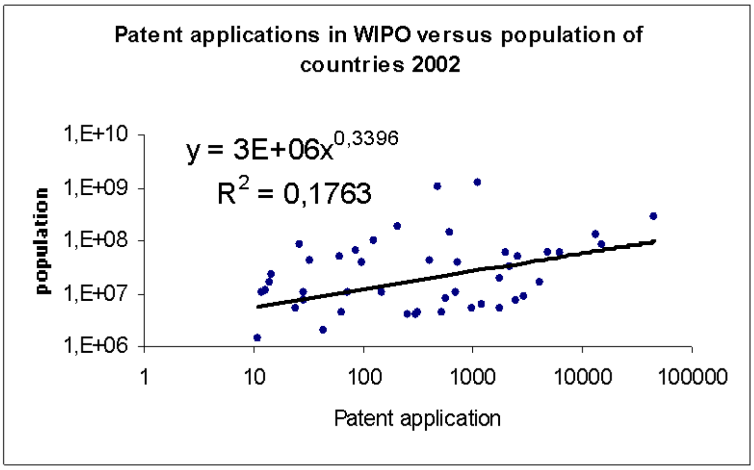

Figure 21: Population versus patent applications in the WIPO by 49 most productive countries in 2002 in power law method[111]

What Figure 21 also shows, is that there is weak correlation between the size of a population and the number of applied patents. The Figure indicates that the bigger the population of a country is; the number of patent application stays almost flat. The reason is that, money for research activities in the countries is more important than the size of population. Although the probability of higher educated people in the countries with high population seems to be greater than in the small countries, this correlation is not as important of an indicator as the wealth of the countries.

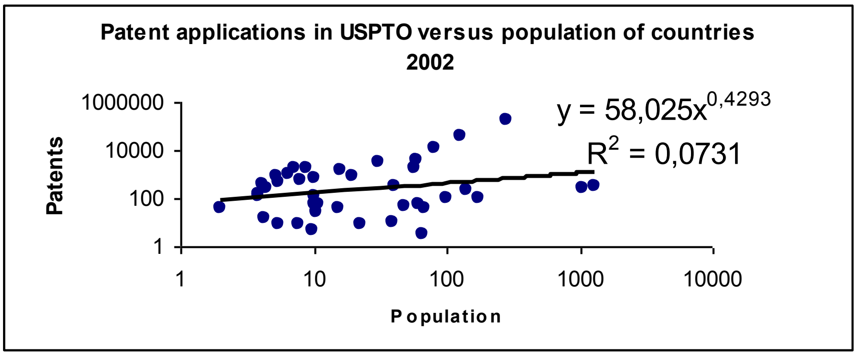

Figure 22: Population versus patents application in the USPTO in 2002

Figure 22 shows the relationship between the numbers of patent application in USPTO versus population of countries in 2002. It is clear that Patent application in the USPTO likewise in the other patent organizations (WIPO and EPO) shows a weak correlation with the population of countries. The reason is that, in a country the wealth progresses the potential for investments; therefore money is more important for research capability than the size of population in a country. In other words the money for the science is more important than the number of the population those can be very differently trained.

With consideration the publications of 40 more productive countries in the SCI versus GDP of countries in 1999 we found a nearly linear correlation (power law) between the number of publications in the SCI and GDP of countries.

[111] Data of population retrieved January 20, 2006 from http://www.mongabay.com/igapo/world_statistics_by_pop.htm.

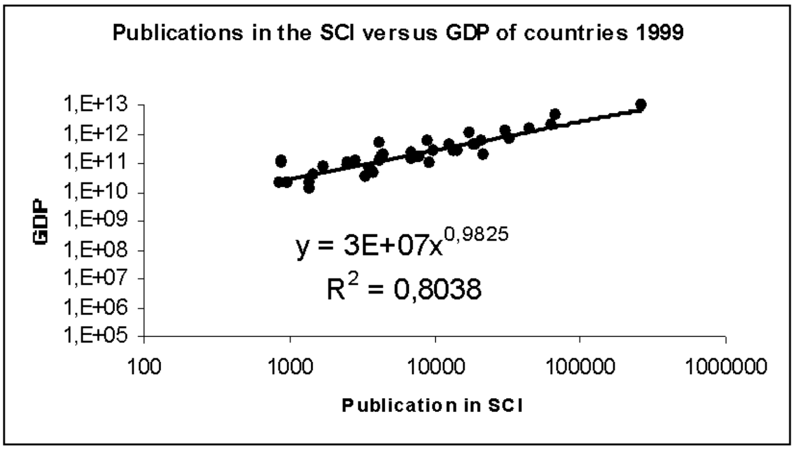

Figure 23: Publications in the SCI versus GDP of 40 more productive countries in 1999

Figure 23 shows the number of publications for 40 more productive countries in the SCI versus GDP. The Figure illustrates that there is a power law (linear approaching) correlation between the GDP of a country and the number of publications in the SCI. in other words the richer the country is, the higher is the number of publications in the SCI.

With consideration the ratio of publications in the SCI for 42 more productive countries in the SCI in 2002, extracted from the study of Heinz M. [112] we found high correlation between the portion of publications in the countries in the SCI and the number of patent applications in WIPO and USPTO.

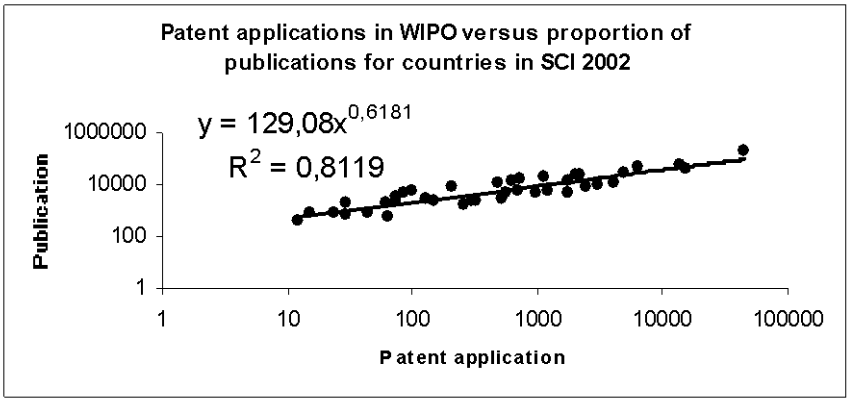

Figure 24: Patent application in the WIPO versus publications in the SCI in 2002

[112] Heinz, Michael (2006). Bemerkungen zur Entwicklung der Internationalität der Forschung – Bibliometrische Untersuchungen am SCI. Retrieved January 12, 2007 from http://edoc.hu-berlin.de/miscellanies/vom-27533/131/PDF/131.pdf

Figure 24 shows the correlation between the patent applications of 39 more productive countries in WIPO with the proportion of publications in the SCI in 2002.

The Figure indicates that there is a power law correlation between the number of publications in the SCI for countries and the number of patent applications in the WIPO. The correlation coefficient is R = 0.90.

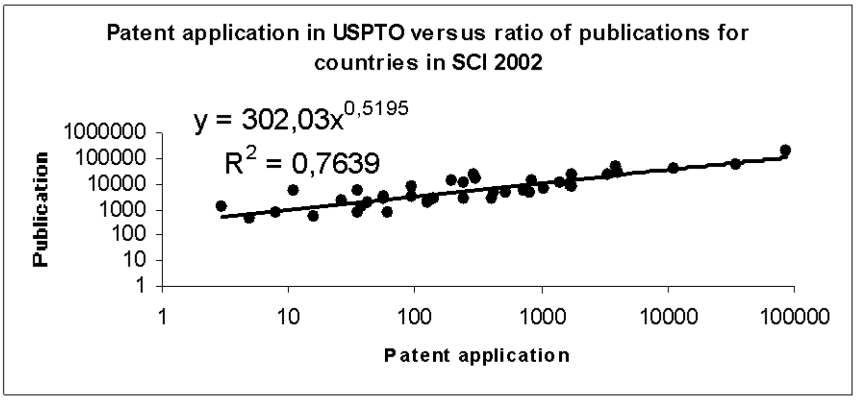

Figure 25: Patent application in USPTO versus the ratio of publications in the SCI by 42 most productive countries in 2002

As Figure 25 shows, there is a power law correlation between the patent application in the USPTO and the portion of publications in the SCI. the more the country has applied for patents in the USPTO, the more is its portion of publication in the SCI.

The correlation coefficient is high (R = 0.88).

5.1 Results of section one:

Analysis of data showed that more than half of all patent applications (58%) as well as granted patents issued by USPTO through 1965-2005 belong to the USA; the portion of other countries throughout the study is 42%. This is in agreement with the study of Rausch L. [113] who found out 55 percent of all granted patents in 1997 were awarded to the USA resident inventors and foreign-origin patents accounted for the remaining 45 percent.

Almost all patents applications in the USPTO were granted.

The study showed that the number of patent applications as well as the number of granted patents from 1965 to 1985 by USA decreased slightly. This is in agreement with the study of Grief S., who found out "In den USA ist ab Beginn der siebziger Jahre eine negative Tendenz bei den Patentanmeldungen zu verzeichnen, die – mit einem Rückgang von 13.000 Anmeldungen in 13 Jahren – zu einem Tiefstand im Jahre 1983 führte."[114]

The number of patent applications and granted patents by other countries (all countries excluding the USA) during the same period increased slightly. It indicates that the portion of scientific activity for the countries all around the world since 1965 has begun to increase.

Since 1986 the number of patent applications as well as the number of grated patents by the USA and other countries enjoyed a sharp increase.

Analysis of data indicated that the USA is the leading country filing patents as well as granting patents, followed by Japan, Germany, U.K., France and Canada. The results of this study verified the study of Yen-Chun Jim Wu[115] who found out that the USA, Japan and Germany were the three top patenting countries through 1991-2001.

The comparison of granted patent rates among Canada, France, Japan, Germany and U.K. showed that before 1975 the patent application as well as granting patents in USPTO by Germany was higher than the four other countries, in other words, since 1975 Germany was the leading country filing and granting patents after the USA in USPTO, but from 1980 the

[113] Rausch, Lawrence M. (1999). U.S. Inventors Patent Technologies zaround the World. Nationa Science Foundation.

[114] Greif, Siegfried (1998). Strukturen und Entwicklungen im Patentgeschehen.In:Wissenschaftsforschung: Jahrbuch 1996/97. Hrsg. v. Siegfried Greif, Hubert Laitko u. Heinrich Parthey. Marburg: BdWi-Verlag 1998. P. 97 - 136.

[115] Wu, Yen-Chun Jim (2005). Unlocking the value of business model patents in e-commerce. The Journal of Enterprise Information Management, Vol. 18 No.1, p. 113-130.

patent activities by Japan increased rapidly, whereas the patent filing by Germany compared to Japan increased slightly; therefore Japan paced ahead Germany.

All the five countries enjoyed relatively rapid increase since 1999.

Analysis of data further showed that, there is a strong correlation between the productivity of a country in the term of patent application as well as scientific publication and GDP. Most probably the positive effects of innovation activities in the countries percolate through the economy of countries and increase income raise the potential for new investments and innovations.

This relationship is a valuable exploration, it makes possible to predict one country's patent application quantity or innovation activity through analysing its GDP and vice versa.

The findings of this study indicated that there is a weak correlation between the amount of patent applications and the size of population in the countries. The reason is most probably, that the money for science is more important than the number of people in not sufficient educated countries. "The World Bank data showed that in high-income countries, there was one (1) domestic patent filing for every 1,300 people (in 1997); in middle-income countries, one (1) patent application for every 20,000 people; and in low-income countries, one (1) patent application was filed for every 144,000 people. There are many related reasons for this discrepancy. One of those reasons is that there are five times as many scientists and technologists in research and development activities in high-income countries than medium-income countries. Low-income countries are even further disadvantaged. This factor along with capital-formation differences between these countries leads to the uneven distribution of economic growth throughout the world." [116]

The number of patent applications in the countries has a strong correlation with the number of publications in the SCI.

6 Section Two: Patent literature in MEDLINE

Analysis of patent literature in MEDLINE throughout 1965-2005

In this section the trend of patent literature in MEDLINE is analysed. All data extracted from the electronic database of PubMed (PubMed is the U.S. National Library of Medicine's MEDLINE, the premier database for health information, a great place to begin a search of the

[116] Przybylowicz, Edwin P. (2003). A challenge to the World's Scientists. Retrieved July 5, 2007 from http://www.iupac.org/publications/ci/2003/2503/oc.html

medical literature. It covers over 4,800 biomedical journals). In order to retrieve all documents about patent literature, the Extraction is restricted to the term "patents" as MeSh Major Topic. The reason of restriction the search in the PubMed is that, Search with MeSh Terms gives better results.

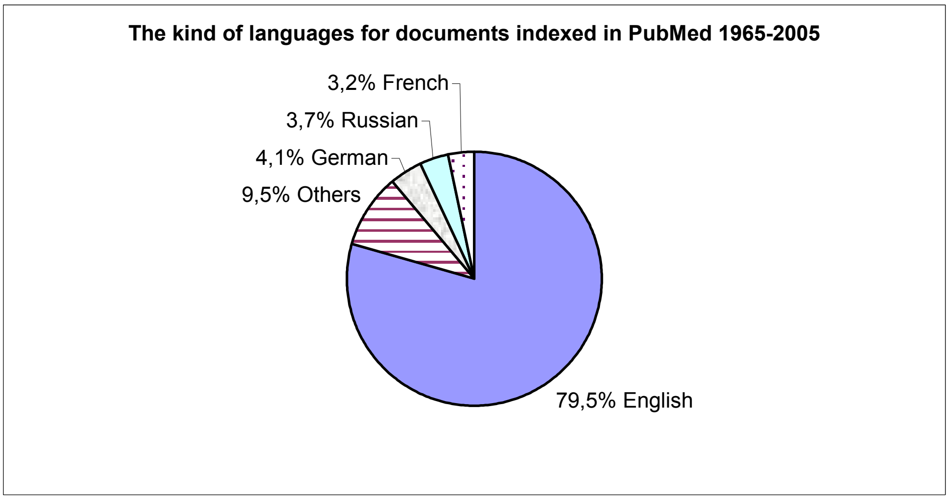

Figure 26: The kind of languages for total documents indexed in PubMed 1965-2005

The Figure shows the kind of languages for total documents indexed in PubMed through 1965-2005. English with 79.5% was the most frequented language in PubMed followed by German with 4.1%, Russian with 3.7% and French with 3.2%. The other languages consisted of 9.5% of total records indexed in PubMed through 1965-2005.

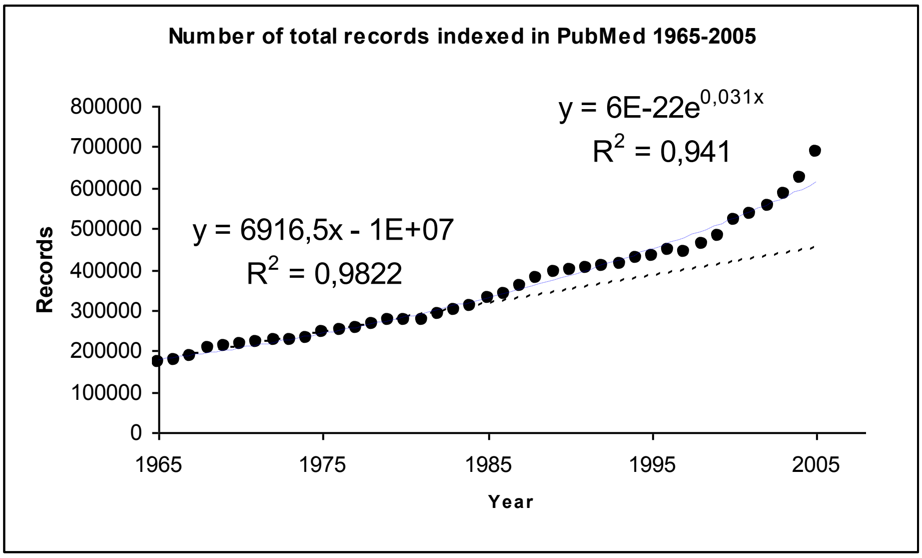

Figure 27: Number of total records indexed in PubMed 1965-2005

Figure 27 shows the total number of records (included all kind of publications) indexed in MEDLINE through 1965-2005.

As the Figure indicates the number of total records in PubMed has a doubling time of 22.5 years. The rate of annual growth is 3.1%. It is clear that the number of total records in PubMed through 1965-1985 shows relatively slight growth. From 1986 to 2005 the number of total records in PubMed shows exponential increase. The exponential increase of documents indexed in the PubMed in this stage should not come as a surprise, because this time was simultaneous with the rapidly spreading microcomputers and the influence of core journals in MEDLINE and in the SCI.

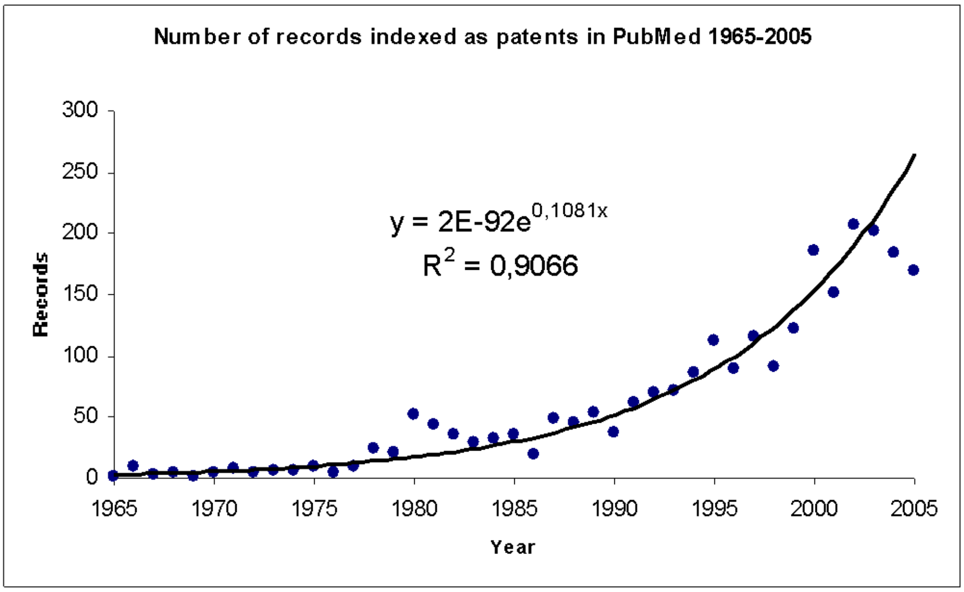

Figure 28: Number of records indexed as patents in PubMed 1965-2005

As Figure 28 illustrates, the number of records indexed as patents (literature about patents) in the field of Major MeSH Descriptors (MJME) in PubMed from 1965 to 198 has increased slightly. Form 1985 it shows relatively sharp growth peaking in 2002.

The formula R^2 = 0.9066 indicates that there is a high correlation (R = 0.95) between the number of patent literature in PubMed and the years of under study.

The patent literature throughout the period of study shows a doubling time of 6.4 years.

Comparison of Figure 27 and Figure 28 indicates that the growth of records indexed as patents in the field of MJME (patent literature) in PubMed with an annual increase of 11.4% is 3.6 times higher than the annual growth of total documents in PubMed (3.1%). It means that patents in medicine have an increasing influence.

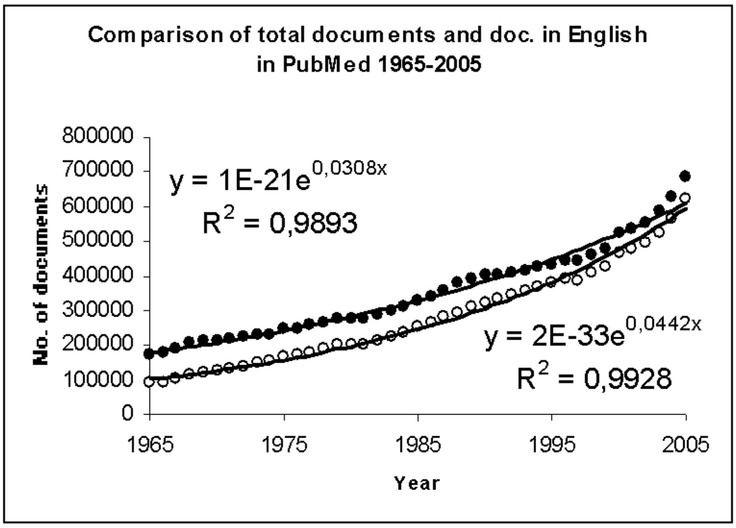

Figure 29: Comparison of total documents (black circles) with documents in English (blank circle) in PubMed 1965-2005

As Figure 29 shows, the growth of Publications in English is 44% higher than the growth of total publications in PubMed. Publications in English show a doubling time of 15.7 years, whereas the total publications in PubMed show a doubling time of 22.5 years throughout 1956-2005. Publications in English increased from 52% in 1965 to 90% of all documents in 2005. This indicates that the policy makers in this database have focused their attention on the literature in English.

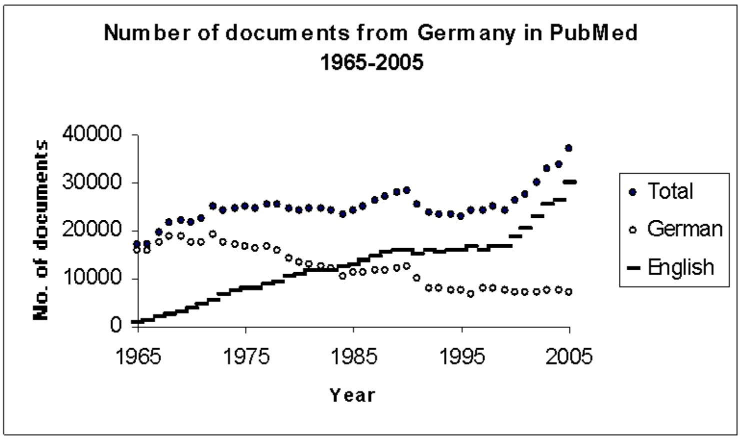

Figure 30: Number of documents from Germany (total number (black circle), documents in English (-), and documents in German (blank circle) 1965-2005

Figure 30 shows that the number of documents published in Germany in English has increased steady throughout the period of study. The proportion of documents in English increased from 6% of all documents for Germany in 1965 to 81% in 2005, an increase of more than 29 times. On the other hand the number of documents in German shows steady decrease through 1965-2005; it fell from 93% of total documents for Germany in 1965 to 19% in 2005.

Table 5: Total No. of documents in PubMed, total documents from Germany, total German documents and documents in English from Germany 1965-2005

Year	Total documents in PubMed	Total doc. from Germany in PubMed	Doc. in German from Germany	% German	Doc. in English from Germany	% English
1965	173,880	17,097	15,922	93%	1,031	6%
1966	175,784	17,215	15,664	91%	1,414	8%
1967	187,783	19,570	17,385	89%	1,973	10%
1968	204,852	21,490	18,597	87%	2,681	12%
1969	212,030	21,931	18,655	85%	3,047	14%
1970	215,656	21,579	17,463	81%	3,865	18%
1971	220,464	22,561	17,619	78%	4,710	21%
1972	223,932	24,796	19,016	77%	5,553	22%
1973	227,409	24,103	17,440	72%	6,477	27%
1974	230,950	24,432	16,880	69%	7,399	30%
1975	245,273	24,833	16,571	67%	8,097	33%
1976	250,155	24,552	16,384	67%	8,056	33%
1977	256,848	25,345	16,464	65%	8,752	35%
1978	266,627	25,212	15,790	63%	9,307	37%
1979	275,633	24,716	14,129	57%	10,430	42%

1980	273,826	24,323	13,280	55%	10,916	45%
1981	276,184	24,540	12,787	52%	11,651	47%
1982	287,336	24,390	12,493	51%	11,772	48%
1983	301,194	23,999	12,128	51%	11,776	49%
1984	310,074	23,163	10,586	46%	12,508	54%
1985	327,155	24,299	11,154	46%	13,052	54%
1986	340,615	25,193	11,381	45%	13,724	54%
1987	358,569	26,049	11,475	44%	14,460	56%
1988	376,980	27,181	11,740	43%	15,345	56%
1989	393,466	28,110	12,255	44%	15,806	56%
1990	400,157	28,157	12,419	44%	15,688	56%
1991	401,638	25,400	10,176	40%	15,162	60%
1992	405,970	23,909	7,860	33%	15,994	67%
1993	413,581	23,355	7,736	33%	15,583	67%
1994	423,661	23,229	7,371	32%	15,791	68%
1995	434,222	23,116	7,419	32%	15,657	68%
1996	444,774	24,139	6,778	28%	16,461	68%
1997	442,966	24,040	8,024	33%	16,037	67%
1998	461,668	24,804	8,056	32%	16,765	68%
1999	480,129	24,157	7,374	31%	16,821	70%
2000	521,442	26,060	7,185	28%	18,914	73%
2001	533,719	27,704	7,288	26%	20,451	74%
2002	553,949	30,107	7,194	24%	22,952	76%
2003	584,267	33,002	7,623	23%	25,413	77%

2004	626,100	33,557	7,342	22%	26,252	78%
2005	687,262	37,111	7,115	19%	30,075	81%

Table 5 shows the total number of documents in PubMed, total number of document for Germany, documents for Germany in German and documents for Germany in English throughout 1965-2005.

Table 6: Total number of documents, documents in French and in English from France 1965-2005

Year	Total document from France in PubMed	Documents in French from France	%French	Documents in English from France	%English
1965	12,685	12,348	97%	286	2%
1966	10,312	10,033	97%	212	2%
1967	11,890	11,589	97%	240	2%
1968	11,735	11,319	96%	359	3%
1969	11,860	11,600	98%	186	2%
1970	12,773	12,332	97%	381	3%
1971	12,486	11,905	95%	526	4%
1972	12,593	11,910	95%	625	5%
1973	9,173	8,417	92%	737	8%
1974	8,938	8,217	92%	731	8%
1975	9,641	8,756	91%	876	9%
1976	9,854	8,814	89%	1,079	11%
1977	9,521	8,570	90%	933	10%

1978	9,829	8,506	87%	1,373	14%
1979	9,908	8,771	89%	1,154	12%
1980	9,622	8,554	89%	1,105	11%
1981	9,210	8,259	90%	1,012	11%
1982	10,093	8,967	89%	1,228	12%
1983	9,555	8,654	91%	977	10%
1984	10,094	8,828	87%	1,357	13%
1985	9,847	8,704	88%	1,243	13%
1986	9,780	8,575	88%	1,283	13%
1987	9,818	8,543	87%	1,340	14%
1988	10,410	8,951	86%	1,532	15%
1989	10,548	9,142	87%	1,460	14%
1990	10,439	8,786	84%	1,693	16%
1991	10,094	8,193	81%	1,949	19%
1992	9,507	7,768	82%	1,789	19%
1993	9,467	7,657	81%	1,875	20%
1994	8,986	7,411	82%	1,601	18%
1995	8,580	6,808	79%	1,781	21%
1996	8,975	6,963	78%	2,010	22%
1997	8,599	6,658	77%	1,941	23%
1998	9,510	6,904	73%	2,642	28%
1999	10,203	7,101	70%	3,105	30%
2000	10,423	7,063	68%	3,381	32%
2001	10,022	6,694	67%	3,337	33%

2002	10,304	6,693	65%	3,627	35%
2003	11,062	7,132	64%	3,933	36%
2004	11,445	7,167	63%	4,289	37%
2005	12,397	7,448	60%	4,973	40%

Table 6 indicates that the number of documents from France in English in PubMed increased from 2% in 1965 to 40% in 2005.

Table 7: Total documents from Russia in PubMed 1965-2005

Year	Total publications from Russia in PubMed	Total publications in Russian from Russia	Total publications in English from Russia	% in English
1965	13,939	13,491	19	0.1%
1966	15,146	14,652	8	0.1%
1967	15,479	15,010	8	0.1%
1968	16,257	15,668	5	0.0%
1969	16,316	15,689	14	0.1%
1970	15,811	15,055	11	0.1%
1971	16,991	16,196	24	0.1%
1972	17,393	16,560	6	0.0%
1973	17,902	17,141	10	0.1%
1974	16,497	15,707	25	0.2%
1975	18,795	18,058	33	0.2%
1976	18,418	17,625	53	0.3%
1977	17,711	16,977	37	0.2%

1978	18,125	17,759	14	0.1%
1979	15,718	15,420	10	0.1%
1980	16,257	16,103	0	0.0%
1981	15,277	15,275	0	0.0%
1982	15,015	15,012	0	0.0%
1983	15,150	15,083	1	0.0%
1984	15,624	15,621	0	0.0%
1985	15,877	15,873	0	0.0%
1986	15,738	15,737	0	0.0%
1987	16,533	16,533	0	0.0%
1988	16,885	16,884	1	0.0%
1989	16,933	16,928	0	0.0%
1990	16,515	16,494	2	0.0%
1991	14,917	14,879	1	0.0%
1992	8,485	8,382	16	0.2%
1993	7,422	7,362	13	0.2%
1994	6,688	6,681	7	0.1%
1995	6,493	6,479	15	0.2%
1996	6,633	6,632	1	0.0%
1997	6,427	6,250	187	2.9%
1998	6,386	6,208	179	2.8%
1999	6,089	5,898	192	3.2%
2000	6,496	6,145	351	5.4%
2001	6,356	6,105	252	4.0%

2002	6,801	6,474	327	4.8%
2003	6,723	6,418	332	4.9%
2004	6,493	6,209	308	4.7%
2005	6,274	6,118	187	3.0%

Table 7 indicates that the most majority of documents from Russia published in Russian. The portion of documents in English consisted only from 0.0% to 5.4% of total document for Russia through 1965-2005.

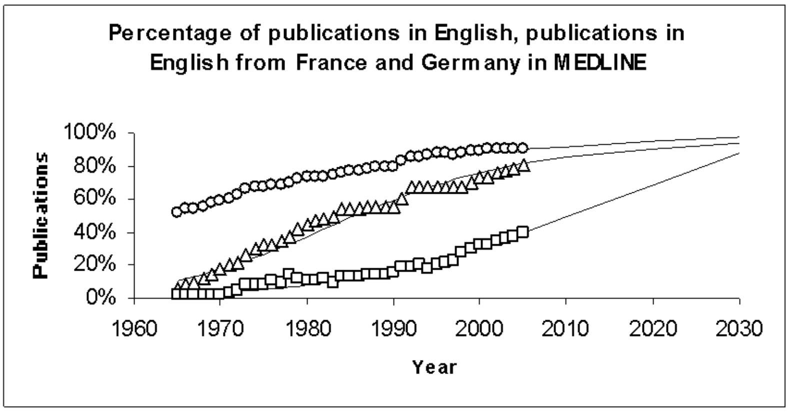

Figure 31: percentage of total publications in English (○), publications in English from Germany (Δ) and France (□) in PubMed 1965-2005

Figure 31 shows the percentage of total publications in English (○), the percentage of publications in English from Germany (Δ), and the percentage of publications in English from France (□) in MEDLINE (PubMed) through 1965-2005.

The Figure estimates that the percentage of publications in English in MEDLINE will reach to the saturation level at 97% in 2030, and the percentage of publications in English from Germany and France will reach to the 94% and 88% respectively in 2030. This is an indication that the editorial policy of Medline is undergoing change. The policy makers of this database have focused their attention on the literature of science in English.

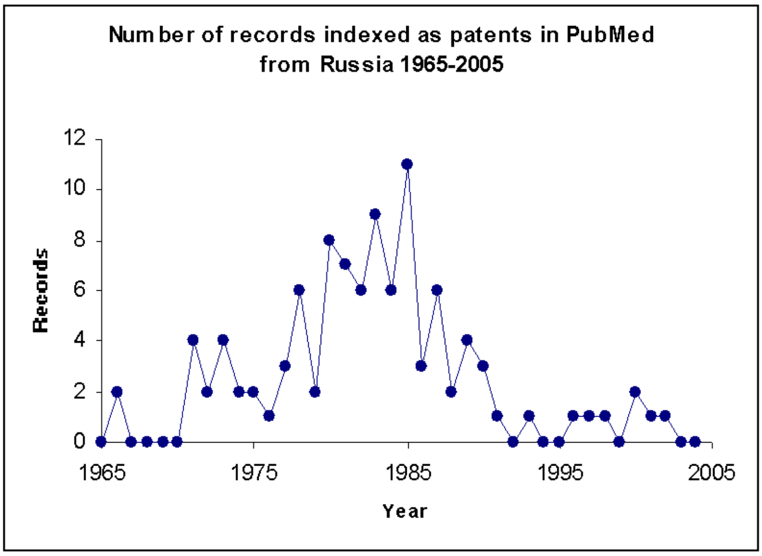

Figure 32: Number of records indexed as patents in the field of MJME from Russia in PubMed 1965-2005

Figure 32 illustrates the number of records indexed as “patents” (patent literature) in PubMed for Russia through 1965-2005. It is evident that the great number of patent literature published by Russia came from 1981-1988.

Although the great number of patent literature published by Russia came from 1981-1988 but the great number of patent applications for this country came during 1970-1980.

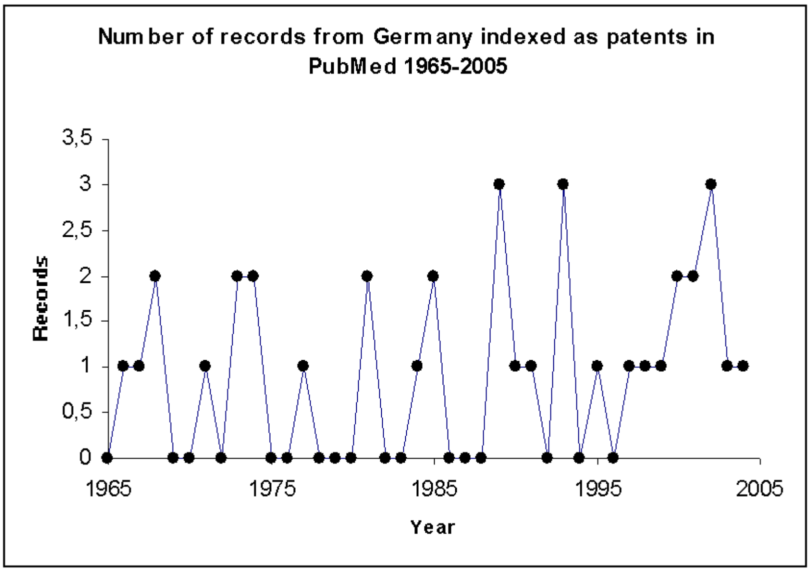

Figure 33: The number of records per year indexed as “Patents” in PubMed for Germany 1965-2005

Figure 33 shows the number of records indexed as patents in PubMed for Germany through 1965-2005 annually. There is no significant growth rate in the Figure, but it is clear that the peak emerged in 2002. From a total number of 37 records indexed as patents in the field of MJME for Germany in PubMed, 29 (78%) of them were in German and only 8 (22%) were in English. As a mean value 1.3 German papers about patent literature were indexed in MEDLINE per year. There was no significant growth rate.

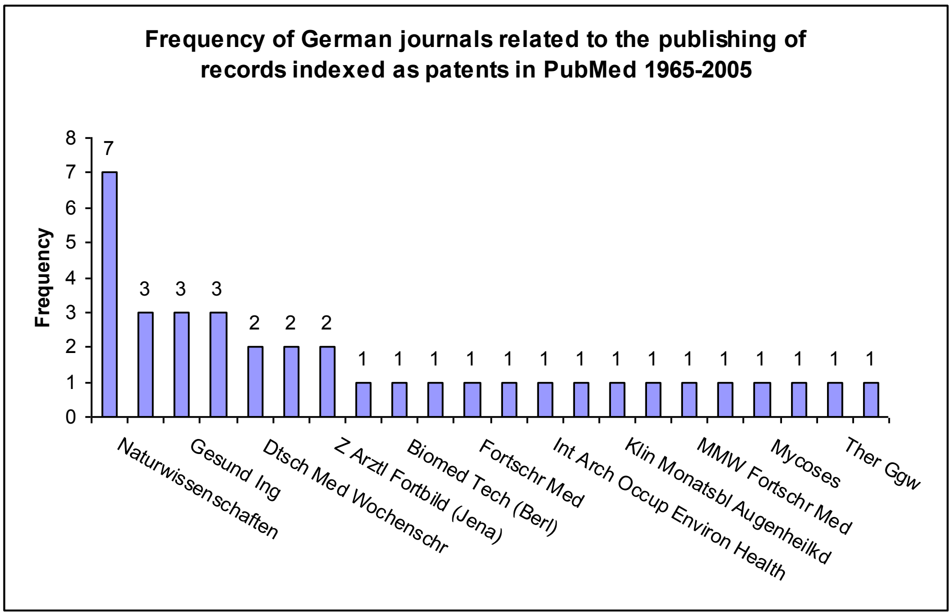

Figure 34: Frequency of German journals, those featured the records indexed as patents in PubMed 1965-2005

Figure 34 illustrates distribution of German journals, those involved in publicising the documents that indexed as patents (literature about patents) in PubMed.

As Figure illustrates, the most prolific German periodical in MEDLINE (PubMed) was *Naturwissenschaften* with publishing 7(19%) of total publications indexed as patents in PubMed, followed by *Dental-echo, Gesundheits-Ingenieur*, and *IIC-international-review-of-industrial-property-and-copyright-law* with 3(8%) for each of them.

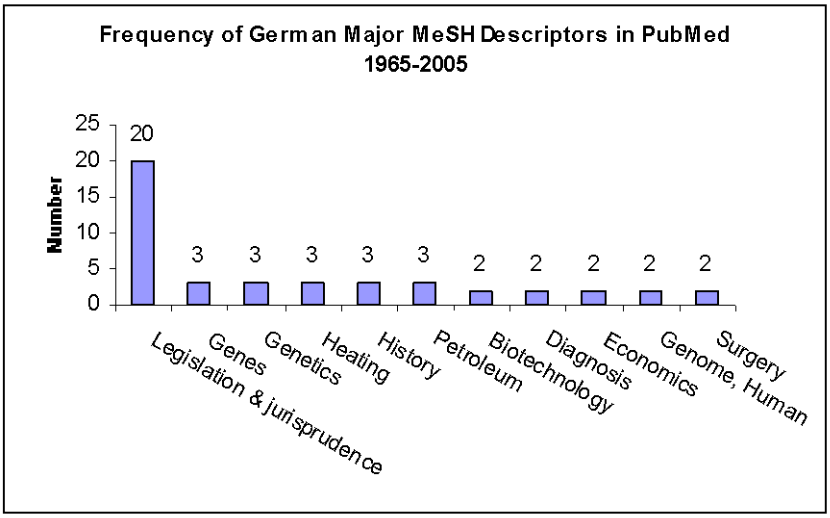

Figure 35: Frequency of German Major MeSH Descriptors in PubMed 1965-2005 (MJME fewer than 2 times were omitted)

Figure 35 shows the distribution of Major MeSH descriptors for documents featured in German journals and indexed as patents in PubMed throughout 1965-2005. The Figure is restricted to the MJME with frequency equal or above 2 times.

As Figure illustrates, after patents-legislation and Jurisprudence, Genes and Genetics are the most frequented Major MeSH Descriptor in MEDLINE (PubMed).

Table 8 shows that from 43 kinds of German Major MeSH Descriptors (MJME) with a total frequency of 77 times, 26% are legislation-and-jurisprudence, 4% Genes, Genetics, Heating, History and Petroleum. The portion of Biotechnology, Diagnosis, Economics, Genome-Human, and Surgery is 3%.

Table 8: Frequency of German Major MeSH descriptors (MJME) in ERL 1965-2005

No	German MJME	Frequency	Percent
1	Legislation& Juricprudence	20	26%
2	Genes	3	4%
3	Genetics	3	4%
4	Heating	3	4%
5	History	3	4%
6	Petrolum	3	4%
7	Biotechnology	2	3%
8	Dignosis	2	3%
9	Economics	2	3%
10	Genome-Human	2	3%
11	Surgery	2	3%
12	Amphotericin B	1	1%
13	Animal Welfare	1	1%
14	Animals, Genetically modified	1	1%

15	Animals, laboratory	1	1%
16	Antibiotics, antifungal	1	1%
17	Antibodies, monoclonal	1	1%
18	Base sequence	1	1%
19	Contact lenses	1	1%
20	Cytology	1	1%
21	Dentistry	1	1%
22	DNA, Recombinant	1	1%
23	Drug industry	1	1%
24	Economic competition	1	1%
25	Equipment and supplies	1	1%
26	Ethics	1	1%
27	Ethics, professional	1	1%
28	Eyeglasses	1	1%
29	Fbromyalgia	1	1%
30	Genetic engineering	1	1%
31	History, 18th century	1	1%
32	Jurisprudence	1	1%
33	Legislation, medical	1	1%
34	Microbiological techniques	1	1%
35	Oligonucleotide array sequence analysis	1	1%
36	Online systems	1	1%
37	Physiology	1	1%
38	Preventive medicine	1	1%
39	Research	1	1%
40	Sequence analysis, dna	1	1%
41	Technology, medical	1	1%
42	Therapeutics	1	1%
43	Trends	1	1%
Total		77	100%

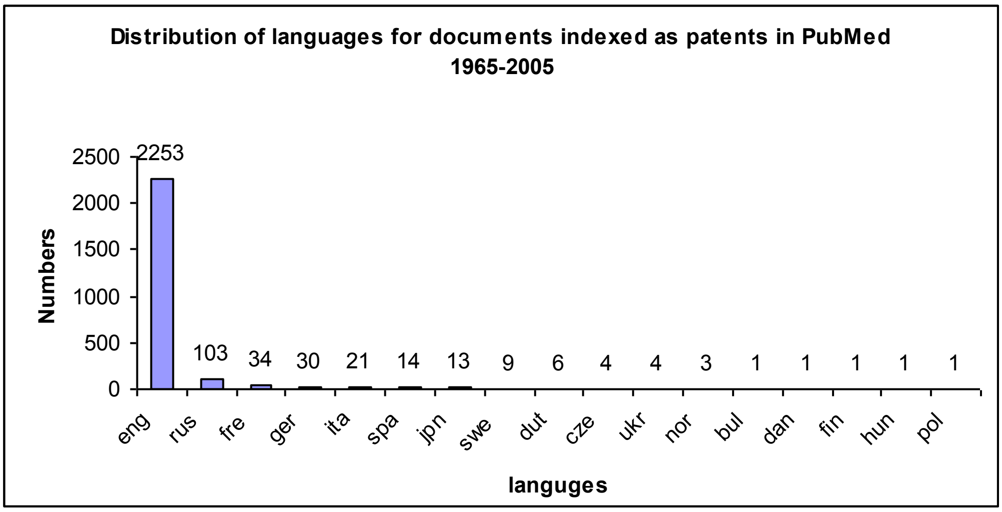

Figure 36: Frequency of languages for documents indexed as patent in PubMed 1965-2005

Figure 36 shows distribution of languages for documents indexed as “patents” (patent literature) in PubMed through 1965-2005. As Figure illustrates, English was about 2,000 times more weighted than the rest.

Russian was about 100 times more weighted than the rest. In other words the most frequented languages of patent literature in PubMed was English followed by Russian, French, and German.

Table 9: Distribution of languages for patent literature in PubMed 1965-2005

Language of documents indexed as patents in PubMed 1965-2005	Frequency	Percent
English	2,253	90.16%
Russian	103	4.12%
French	34	1.36%
German	30	1.20%
Italian	21	0.84%
Spanish	14	0.56%
Japanese	13	0.52%
Swedish	9	0.36%
Dutch	6	0.24%
Czech	4	0.16%
Ukrainian	4	0.16%
Norwegian	3	0.12%
Bulgarian	1	0.04%
Danish	1	0.04%
Finish	1	0.04%
Hungarian	1	0.04%
Polish	1	0.04%
Total	2,499	100.00%

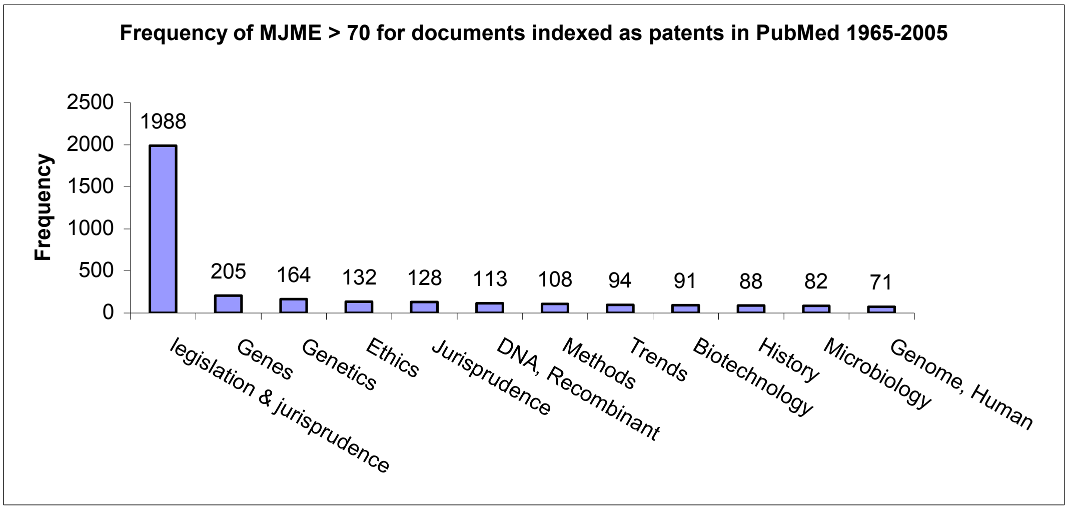

Figure 37: Distribution of Major Mesh descriptors > 70 for documents indexed as patents in PubMed 1965-2005

Figure 37 shows the distribution of MJME for documents indexed as "patents" in PubMed through 1965-2005. The Figure is restricted to the MJME with frequency above 70 times.

From a total of 6,869 Major MeSH Descriptors, the most often used show such a distribution.

The Figure indicates that after legislation-and-jurisprudence the most frequented major main heading in MEDLINE were Genes with 2.98% and Genetics with 2.39% respectively.

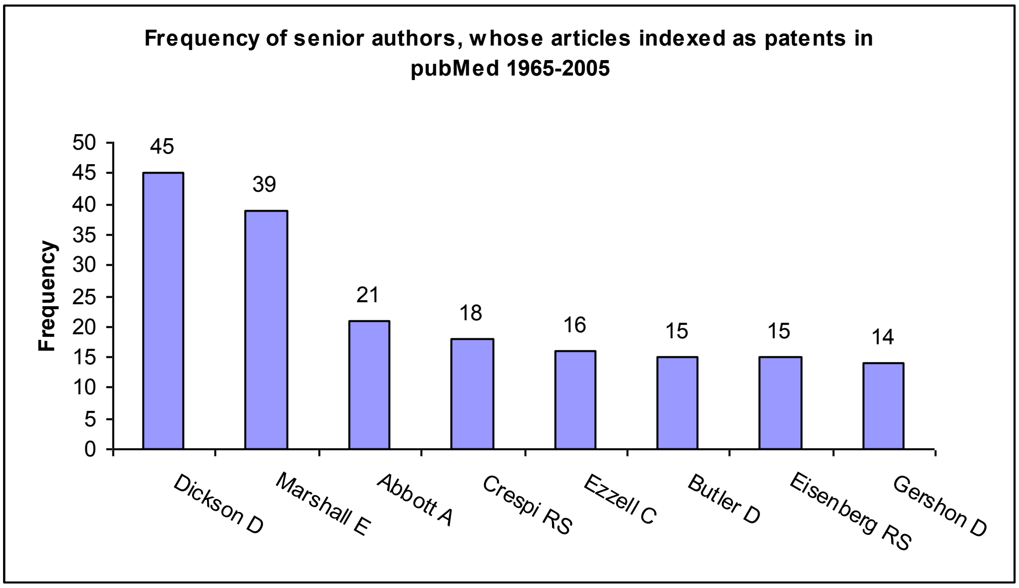

Figure 38: Frequency of senior authors for documents that indexed as patents in ERL 1965-2005

Figure 38 shows the frequency of most prolific authors (senior authors) regarding to the documents that indexed as patents (patent literature) in PubMed through 1965-2005.

From a total of 2,126 authors with total frequency of 3,122 times in PubMed, whose name frequented more than 14 times listed in this Graph.

It should be noted that a total of 173 (5.5%) authors name in MEDLINE (PubMed) stayed anonymous.

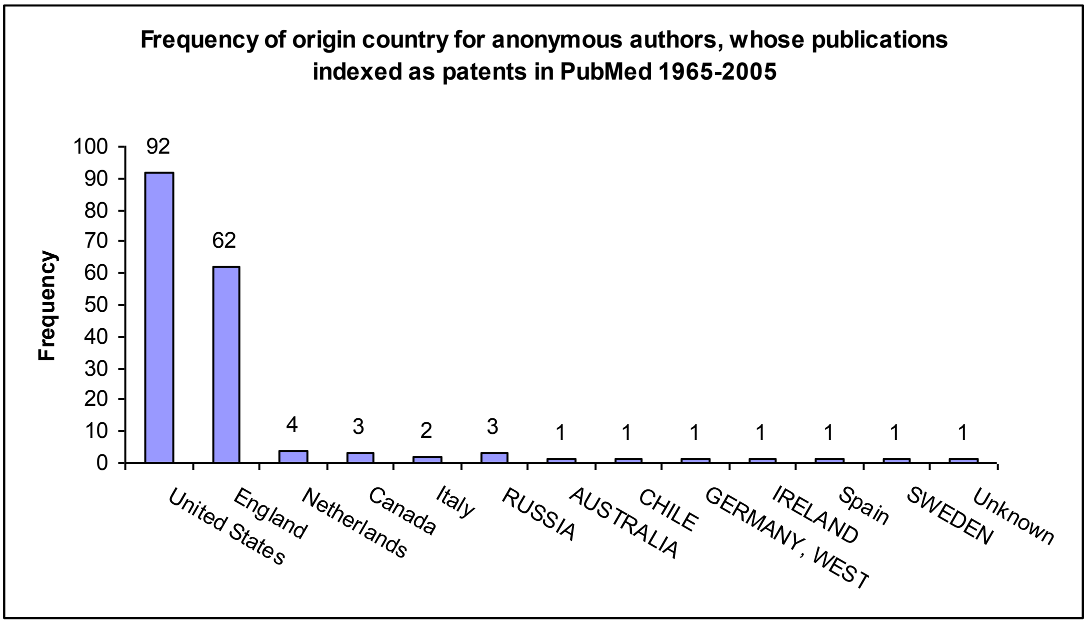

Figure 39: Distribution of origin countries for anonymous authors, whose publications indexed as patents in PubMed through 1965-2005

The Figure shows the frequency of origin countries for anonymous authors, whose articles indexed as patents in the field of MJME in PubMed throughout 1965-2005.

As Figure illustrates from a total of 173 anonymous authors for documents that indexed as patents (patent literature) in PubMed, 92(53.18%) were from the United States and 62(35.84%) from England. In other words about 90% of anonymous authors were from USA and England. The rest 10.98% were from Netherlands, Canada, Russia, Australia, Chile, Germany, Ireland, Spain and Sweden. The origin of one anonymous author stayed unknown.

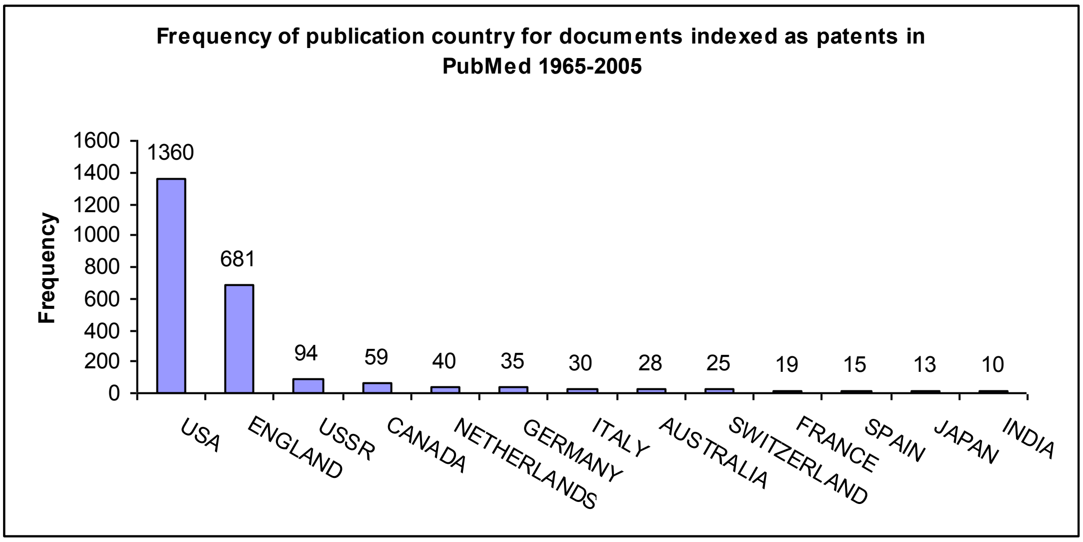

Figure 40: Distribution of publication countries for documents indexed as patents in PubMed 1965-2005

Figure 40 shows the frequency of most prolific countries, regarding to the documents, indexed as patents in the field of MJME in PubMed through 1965-2005. The graph is restricted to the countries that appeared more than 10 times. It is clear that the USA with 55% was the most productive country, followed by England with 27%, USSR with 4%, Canada with 2%, Netherlands with 1% and Germany with 1% were respectively more productive countries. The rest which consisted altogether 4% of all publication countries were Italy, Australia, Switzerland, France, Spain, Japan, India, Sweden, Russia, Poland, Denmark, Ireland, New Zealand, Ukraine, Brazil, Czechoslovakia, Norway, Scotland, South Africa, Argentina, Bulgaria, Chile, China, Colombia, Czech republic, Finland, Hungary, Kyrgyzstan, Mexico, Russia (Federation), Slovakia, Sri Lanka respectively.

The publication country of four documents stayed unknown in MEDLINE (PubMed).

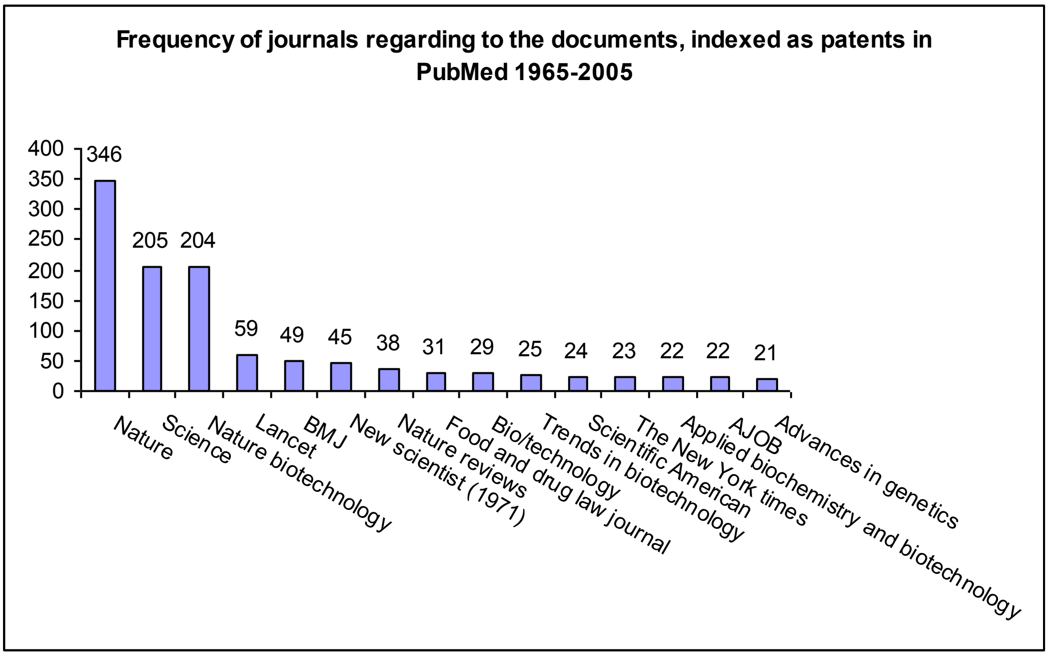

Figure 41: Distribution of journals regarding to the documents, indexed as patents in PubMed 1965-2005

Figure 41 shows frequency of most prolific journals regarding to the documents, indexed as patents in the field of MJME in PubMed through 1965-2005. The graph is restricted to the journals with frequency above 20 times.

From a total of 671 periodical with a total frequency of 2,482 titles, only 15 showed a frequency higher than 20.

Nature with publishing 14% of all documents, indexed as ***patents*** (patent literature) in PubMed was the most prolific periodical, followed by *Science* with 8%, *Nature-biotechnology* with 8%, *Lancet* with 2%, *BMJ (Clinical research ed.)* with 2%, *New Scientist* with 2%, and *Food and drug law* with 1% respectively.

Table 10: Distribution of publication type regarding to the documents indexed as patents in PubMed 1965-2005

No.	Publication type of records indexed as patents in PubMed 1965-2005	Frequency	Percent
1	Journal Article	1,460	46%
2	News	701	22%
3	Letter	170	5%
4	Comment	147	5%
5	Review	141	4%
6	Editorial	112	3%
7	Newspaper Article	76	2%
8	Research Support	74	2%
9	Historical Article	71	2%
10	English Abstract	55	2%
11	Bibliography	30	1%
12	Comparative Study	29	1%
13	Biography	26	1%
14	Legal Cases	26	1%
15	Research Support, U.S. Gov't, P.H.S.	15	0%
16	Research Support, U.S. Gov't, Non-P.H.S.	14	0%
17	Congresses	12	0%
18	Evaluation Studies	11	0%
19	Interview	7	0%
20	Validation Studies	7	0%
21	Case Reports	4	0%
22	Classical Article	4	0%
23	Guideline	4	0%
24	Addresses	2	0%
25	Clinical Trial	2	0%
26	Directory	2	0%
27	Controlled Clinical Trial	1	0%
28	Government Publications	1	0%
29	Lectures	1	0%
30	Overall	1	0%
31	Research Support, N.I.H., Extramural	1	0%
	Total	3,207	100%

Table 10 maps the distribution of publication type for documents, indexed as patents in PubMed through 1965-2005.

From a total of 31 publications kind with a total frequencies of 3,207 titles, 46% of all publications were in the form of journal Articles, 22% in the form of News, 5% Letter, 5% Comment, 4% Review, 3% Editorial, 2% Newspaper Article, 2% Research Support, 2% English Abstract. The rest were lower than 2%.

6.1 Result of section two:

Analysis of data indicated a slight growth for patent literature in MEDLINE from 1965 to 1985. Since 1986 it showed relatively sharp growth, peaking in 2002.

The patent literature throughout the period of study overall showed a doubling time of 6.4 years with an annual growth rate of 11.4%. This rate was 3.6 times higher than the annual growth rate of total publications in PubMed. The annual growth rate of total publication in PubMed was 3.1%.

From 37 German documents indexed as patents in the field of MJME in PubMed , 29 (78%) of them were published in German and only 8 (22%) documents were in English.

Journal "*Naturwissenschaften"* was the most prolific German journal regarding to publishing the documents, indexed as patents in MEDLINE through 1965-2005.

More than 90% (90.16%) of all documents indexed as "***patents****"* in MEDLINE (PubMed) were in English followed by Russian (4.12%), French (1.36%) and German (1.20%).

The study indicated that Genes and Genetics was the most frequented Major MeSH Descriptors (Main Heading) in PubMed throughout the period of study. This is agreement with the announcement of John J. Doll (director of biotechnology for the U.S. Patent and Trademark Office) "*since 1980 we have granted more than 20,000 patents on genes or other gene-related molecules [for humans and other organisms]. And we also know that we have more than 25,000 applications outstanding that actually claim genes or related molecules*."[117]

From a total number of 6,869 Major MeSH Descriptors (Main Headings) in PubMed, after legislation & jurisprudence, Genes with 2.98% and Genetics with 2.39% were the most frequented Major MeSH Descriptors.

From a total of 2,126 authors whose articles indexed as patents with total frequency of 3,122 times in MEDLINE, 173 (5.5%) of them were anonymous; 92 (53.18%) of anonymous authors were from the United States and 62 (35.84%) from England. In other words, about 90% of anonymous authors were from the USA and England. The rest 10.98% were from Netherlands, Canada, Russia, Australia, Chile, Germany, Ireland, Spain and Sweden. The origin of one anonymous author stayed unknown.

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[117] Doll, John J. (2001), Retrieved June 21, 2007 from http://www.sciam.com/article.cfm?chanID=sa006&colID=7&articleID=0008148C-3D5D-1C6F-84A9809EC588EF21

Most prolific authors related to the publishing of articles indexed as patents in PubMed were respetiviely: Dickson D.; Marshall E; Abbott A; Ezzell C. Crespi R.S.: Eisenberg RS.; Butler D. and Gershon D .

The USA with publishing 55% of all documents indexed as patents in PubMed was the most productive country in the term of patent literature, followed by England with 27%, USSR with 4%, Canada with 2%. It is remarkable that 82% of all publications belonged to the USA and England; only 18% of publications belonged to other countries in the world. The origin country of four documents stayed unknown (in MEDLINE).

Journal "*Nature*" with publishing 14% of all documents, indexed as patents (patent literature) in PubMed was the most prolific periodical, followed by journal "*Science*" with 8%, "*Nature-biotechnology"* with 8%, "*Lancet*" with 2%, "*BMJ*" with 2%, "New Scientist" with 2% and "Food and drug law" with 1% respectively.

From a total of 31 publications kind regarding to the documents indexed as patents in PubMed with a total frequencies of 3,207 titles, 46% of all publications were in the form of journal Articles, 22% in the form of News, 5% Letter, 5% Comment, 4% Review, 3% Editorial, 2% Newspaper Article, 2% Research Support, 2% English Abstract. The rest were less than 2%.

The study further showed that the doubling time of total publications in MEDLINE (PubMed) in English was 44% faster than the doubling time of total publications in MEDLINE throughout 1965-2005. The doubling time of total publications was 22.5 years whereas the doubling time for publications in English was 15.7 years. The proportion of documents in English showed considerable increase through 1965-2005. It reached from 52% in 1965 to 90% in 2005 an increase of 72%. Analysis of study predicted that the percentage of publications in English in MEDLINE will reach to the saturation level at 97% in 2030 (Figure 34). This indicates that the editorial policy of entering data to the database of MEDLINE is being changed, and the policy makers of this database have focused on the literature in English.

The total number of publications for Germany in MEDLINE enjoyed relatively slight growth during 1984-1998. From 1990 it begun to fall until 1996. This fall was simultaneous with the fall of publications in German which showed continues decline since 1990.

The number of publications for Germany in German dropped from 93% of total publications in 1965 to 19% in 2005.

The proportion of publications for Germany in English rose considerable since 1999. The percentage of publications in English increased from 6% in 1965 to 81% in 2005.

The increasing number of publications in English has caused to increase the number of total publications for Germany dramatically.

In spite of decreasing trend of publications in German, the number of publications in English for Germany rose. Accordingly the number of publications for Germany showed a sharp rise since 1999.

The number of publications for France in MEDLINE decreased steady from 1990 to 1997. Since 1998 it showed a relatively sharp growth. Since 1998 the proportion of publications for France in English showed a considerable rise; whereas the number of publications in French dropped since 1989. The decreasing trend of publications in French for France continued to the end of fiscal year 2005.

Since 1990 there was a drop for the number of publications for Russia in MEDLINE. Since 1997 the number of publications in English rose and consisted at an average of 4% of total publications through 1997-2005. On the other hand, the number of publications for Russia in Russian decreased dramatically since 1989; whereas the number of publications in English increased considerably since 1993.

One of the most interesting findings of the study is that, evidently the reduction of publications in domestic languages from different countries was due to the changing of editorial policy in MEDLINE. The study showed that the percentage of publications in English from all countries have increased throughout the period of study; whereas the percentage of publications in English increased.

7 Section three: Patent Literature in the SCI

Analysis of patent literature in the Science Citation Index throughout 1965-2005

In this section the trend of patent literature in the Science Citation Index is analysed.

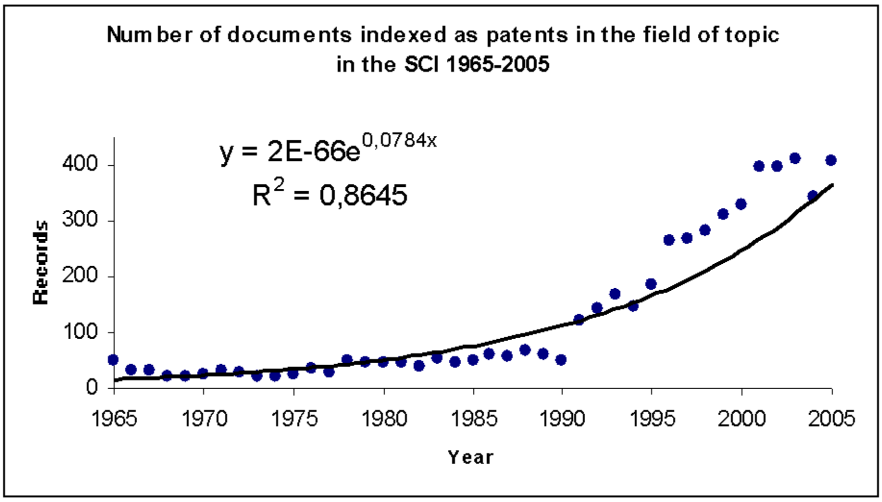

Figure 42: Number of documents indexed as patents in the field of Topic in the Science Citation Index 1965-2005

Figure 42 shows that the number of documents indexed as patents in the field of topic in the SCI from 1965 to 1990 increased slightly, in spite of some fluctuation throughout the years. Form 1991 it shows sharp growth, peaking in 2003.

The patent literature throughout the period of study overall showed a doubling time of 8.8 years.

Table 11: Number of documents indexed as patents (patent literature) in the SCI 1965-2005

Year	No. of documents indexed as a topic of patents in the SCI
1965	49
1966	31
1967	33
1968	22
1969	23
1970	26

1971	31
1972	29
1973	20
1974	20
1975	26
1976	35
1977	30
1978	49
1979	48
1980	45
1981	47
1982	41
1983	52
1984	45
1985	51
1986	59
1987	57
1988	69
1989	59
1990	49
1991	122
1992	144
1993	167
1994	145
1995	184
1996	263
1997	269
1998	283
1999	309
2000	330
2001	395
2002	397

2003	410
2004	344
2005	406

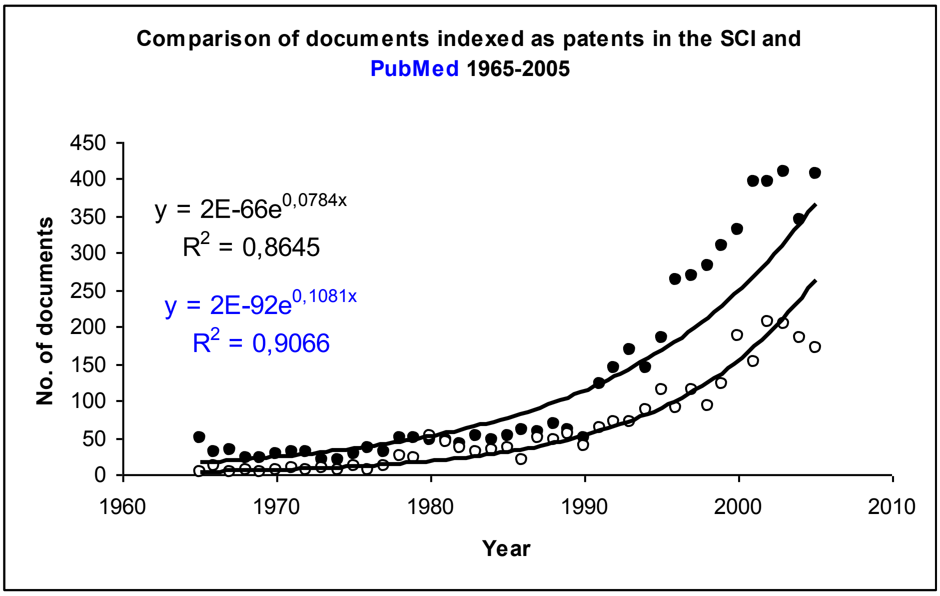

Figure 43: Comparison of patent literature in the Science Citation Index (●) and in PubMed (○) 1965-2005

Figure 43 shows the number of documents indexed as patents (patent literature) in the field of MJME in PubMed (○) and as patents in the field of Topic in the SCI (●) through 1965-2005. The graph indicates that patent literature in the Science Citation Index was higher than in MEDLINE (PubMed); but the growth of patent literature in MEDLINE since 1982 shows higher growth than in the SCI. it indicates that in the last two decades the interesting subject area of researchers has focused on the medical fields.

The doubling time of patent literature in the SCI throughout the period of study was 8.8 years, whereas the doubling time of patent literature in MEDLINE was 6.4 years.

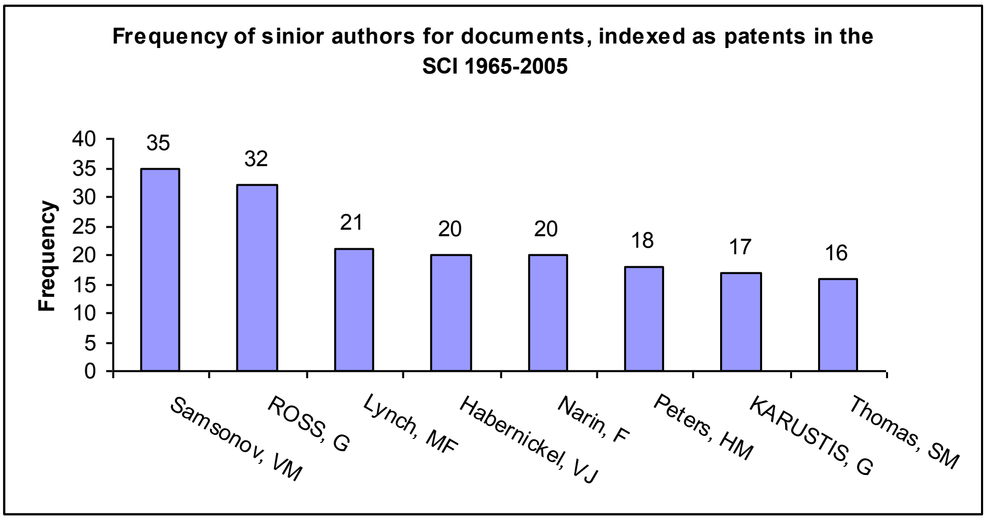

Figure 44: Most frequented authors of documents, indexed as patents in the field of Topic in the SCI 1965-2005

Figure 44 shows the distribution of authors, whose publications indexed as "patents" in the field of Topic in the SCI.

From a total of 7,056 authors with a total frequency of 9,043 times, whose frequencies were higher than 15 times listed in this graph. As the graph illustrates Samsonov, VM with 0.39%, Ross, G with 0.35%, Lynch, MF with 0.23% and Habernickel, VG and Narin, F both 0.22% were the most prolific authors respectively.

It is considerable that 458 (5%) authors of documents in the term of patents in the SCI stayed anonymous.

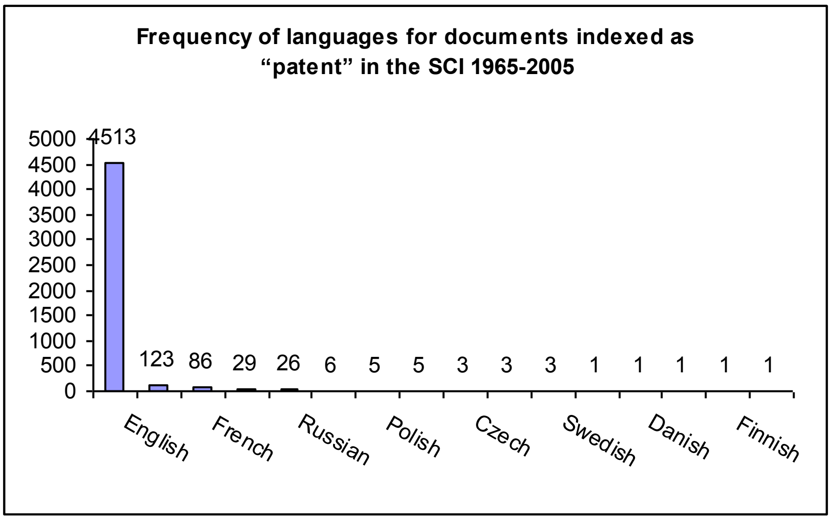

Figure 45: Frequency of languages for documents indexed as "patent" in the SCI 1965-2005

From a total of 16 kinds of language for documents indexed as patents in the field of Topic in the SCI with total frequency of 4,807 times, English with 93.88% was the most frequented language of patent literature in the SCI, followed by German with 2.56%, French with 1.79% and Spanish with 0.60% throughout the period of study.

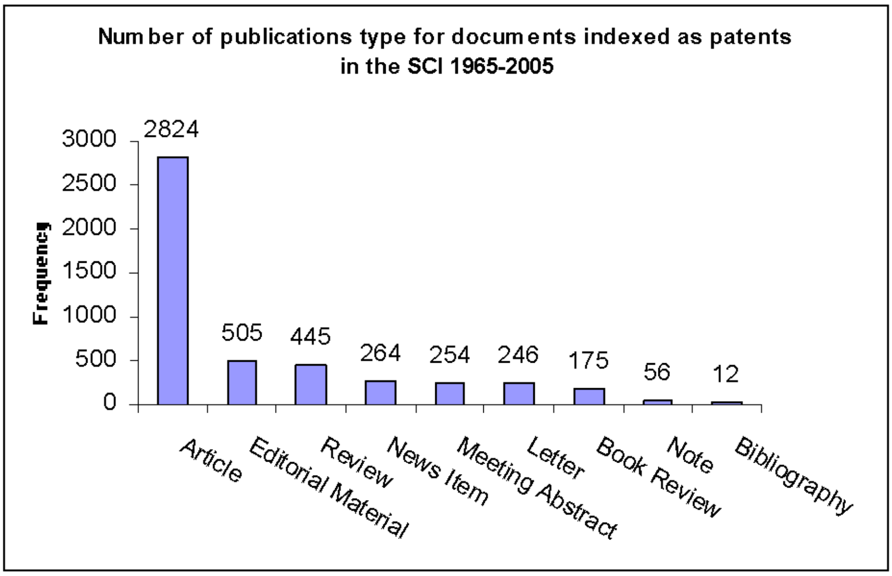

Figure 46: Distribution of publication type for documents indexed as patents in the Science Citation Index 1965-2005

Figure 46 shows the number of publications type for documents indexed as patents in the SCI through 1965-2005.

From a total of 19 publications type for patent Literature in the SCI with a total frequency of 4,808 whose frequencies were more than 10 times listed in this graph.

As the Figure shows Journals article with 58.74% of all publications type is the most frequented publication type of patent Literature in the SCI followed by editorial-materials with 10.50%, reviews with 9.26%, news-item with 5.49%, meeting-abstract with 5.28% and letters with 5.12%.

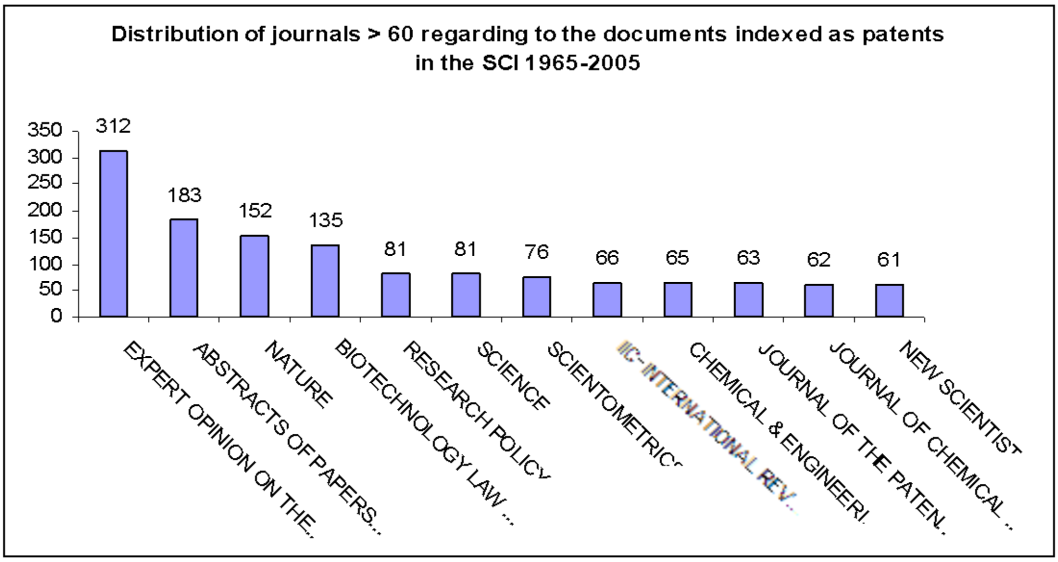

Figure 47: Distribution of Journals (those more frequently publicized patent Literature) in the Science Citation Index 1965-2005

Figure 47 shows the distribution of most prolific journals, those frequently published documents, indexed as patents in the SCI through 1965-2005.

From a total of 1,448 kind of periodicals with a total frequency of 4,810 times, 6.49% journal "*Expert Opinion on Therapeutic Patents*", 3.80% "*Abstracts of Papers of the American Chemical Society*", 3.80% *Nature* and 2.81% "*Biotechnology Law Report"*.

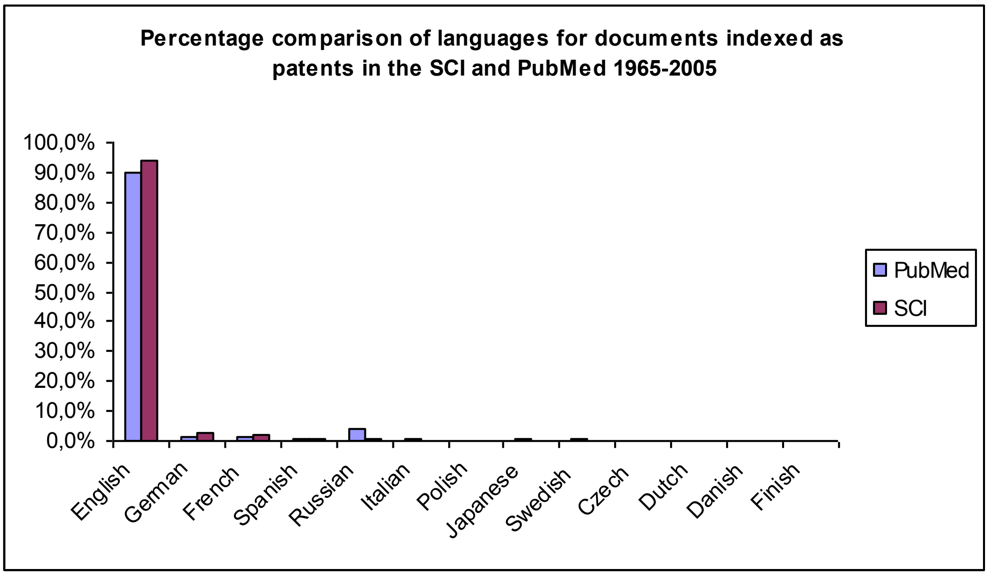

Figure 48: Percentage comparison of languages for documents indexed as patents in the SCI and PubMed 1965-2005

As Figure 48 illustrates English is the most frequented language of documents indexed as patents (patent Literature) in the SCI, with 93.88% of all publication followed by German with 2.56% and French with 1.79%.

The most frequented language of patent Literature in MEDLINE is English with 90.16% of all publications indexed as patents in PubMed followed by Russian with 4.12%, French 1.36% and German 1.2%.

It is clear that the percentage of English language for patent Literature in SCI is 3.70% higher than in MEDLINE and the percentage of Russian in PubMed is 3.6% higher than in the SCI.

In the SCI some records were found in polish, Portuguese and Chinese, but such languages weren't found in MEDLINE. In contrast there are records in Ukrainian, Norwegian, Bulgarian and Hungarian languages in MEDLINE whereas there aren't such languages in the SCI.

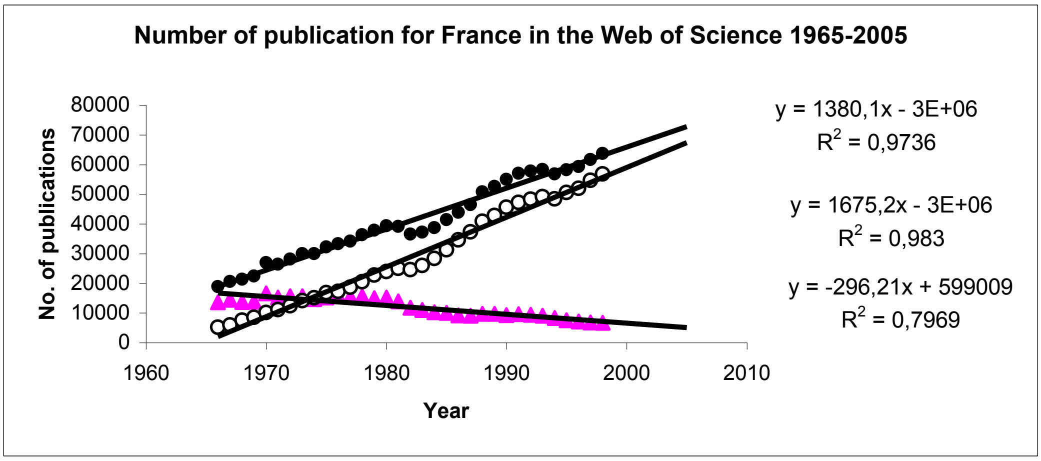

Figure 49: Distribution of total publications (●), publications in English (○) and French (∆) from France 1965-2005

Figure 49 shows the total number of Publications (●), publications in English (○) and French (∆) for France indexed in the Web of Science through 1965-2005

As the Figure indicates, the number of total publications for France in spite of a fall in 1989 has steady increased throughout 1965-2005. Evidently the graph indicates that the fall of publications of France in 1989 was due the fall of publications in French.

The number of publication in English language enjoyed a steady growth through 1970-2005.

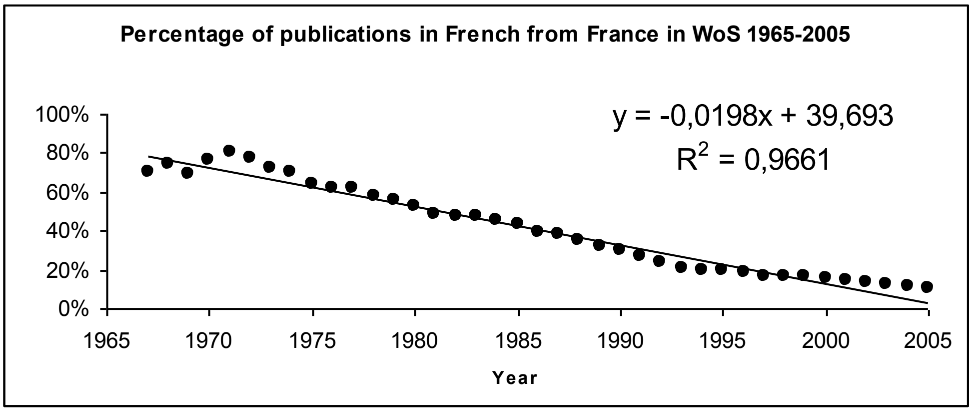

Figure 50: Percentage of publications in French from France in the Web of science 1965-2005

As Figure indicates, the percentage of publications in French from France declined relatively sharp through 1965-1993. Since 1994 it shows a slight decline. Apparently it is reaching to the saturation level.

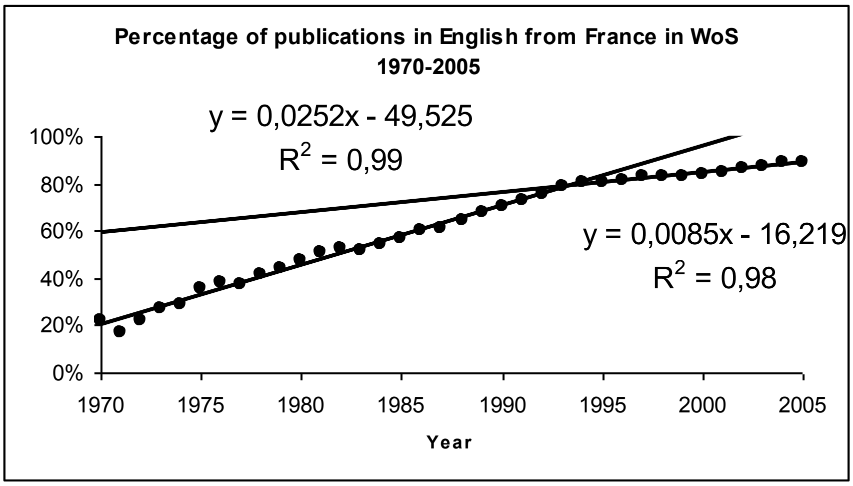

Figure 51: percentage of publications in English from France in the Web of Science 1970-2005

As the Figure 51 indicates, the percentage of publications in English from France divided into two periods. It shows an increase of 25% annually through 1970-1993. Since 1994 it shows a slight increase with 0.08% annually.

Table 12: Total number of publications, publications in French and in English for France through 1965-2005

Year	Total publications from France in the Web of Science	Total publications in French from France in the Web of Science	%publications in French from France	Total publications in English from France in the Web of Science	%of publications in English from France
1965	0	0		0	
1966	345	242	70%	92	27%
1967	418	293	70%	92	22%
1968	393	293	75%	94	24%
1969	403	277	69%	119	30%
1970	663	505	76%	146	22%
1971	728	586	80%	125	17%
1972	3,255	2,508	77%	710	22%
1973	18,817	13,535	72%	5,167	27%
1974	20,552	14,459	70%	5,966	29%
1975	21,334	13,659	64%	7,556	35%
1976	22,412	13,788	62%	8,472	38%
1977	26,967	16,626	62%	10,156	38%
1978	26,434	15,177	57%	11,077	42%
1979	28,190	15,635	55%	12,398	44%
1980	29,948	15,658	52%	14,112	47%
1981	29,996	14,644	49%	15,148	51%

1982	32,207	15,206	47%	16,843	52%
1983	33,289	15,814	48%	17,294	52%
1984	34,207	15,395	45%	18,618	54%
1985	36,360	15,672	43%	20,499	56%
1986	37,840	14,967	40%	22,721	60%
1987	39,324	15,197	39%	23,959	61%
1988	39,088	13,857	35%	25,049	64%
1989	36,508	11,723	32%	24,630	67%
1990	37,146	10,989	30%	26,002	70%
1991	38,707	10,209	26%	28,327	73%
1992	41,406	9,983	24%	31,256	75%
1993	43,914	9,126	21%	34,620	79%
1994	46,456	9,013	19%	37,286	80%
1995	50,804	9,716	19%	40,887	80%
1996	52,666	9,727	18%	42,768	81%
1997	55,012	9,231	17%	45,607	83%
1998	56,993	9,564	17%	47,211	83%
1999	57,835	9,385	16%	48,261	83%
2000	58,339	9,031	15%	49,139	84%
2001	56,869	8,270	15%	48,410	85%
2002	58,269	7,521	13%	50,565	87%
2003	59,309	7,161	12%	51,972	88%
2004	61,619	6,756	11%	54,694	89%
2005	63,725	6,728	11%	56,797	89%

Table 13: Total number of publications, publications in German and in English from Germany in the Web of Science through 1965-2006

Year	Total number of publications from Germany in the Web of Science	Publications in German	% German	Publications in English	% English
1970	821	601	73%	257	31%
1971	736	497	68%	232	32%
1972	3,492	2,195	63%	1,233	35%
1973	24,156	14,345	59%	9,612	40%
1974	26,298	15,896	60%	10,202	39%
1975	28,114	14,630	52%	13,249	47%
1976	24,150	10,898	45%	13,012	54%
1977	36,627	19,584	53%	16,716	46%
1978	41,141	21,971	53%	18,870	46%
1979	41,147	20,880	51%	19,984	49%
1980	41,531	20,350	49%	20,876	50%
1981	45,878	21,828	48%	23,754	52%
1982	49,681	23,243	47%	26,104	53%
1983	47,948	20,460	43%	27,228	57%
1984	47,447	19,199	40%	28,013	59%
1985	51,177	19,673	38%	31,287	61%
1986	52,434	19,795	38%	32,432	62%
1987	53,467	18,392	34%	34,843	65%
1988	51,765	17,022	33%	34,537	67%

1989	48,956	15,171	31%	33,609	69%
1990	52,109	15,571	30%	36,227	70%
1991	52,627	13,949	27%	38,443	73%
1992	53,376	11,710	22%	41,445	78%
1993	56,279	11,797	21%	44,184	79%
1994	59,287	11,084	19%	47,925	81%
1995	64,752	11,228	17%	53,259	82%
1996	69,255	11,114	16%	57,822	83%
1997	77,333	11,700	15%	65,338	84%
1998	80,894	11,994	15%	68,593	85%
1999	82,050	12,065	15%	69,659	85%
2000	83,021	11,615	14%	71,146	86%
2001	82,583	10,785	13%	71,533	87%
2002	85,185	10,183	12%	74,688	88%
2003	85,760	9,654	11%	75,894	88%
2004	90,919	9,459	10%	81,215	89%
2005	94,286	9,725	10%	84,332	89%
2006	96,819	10,083	10%	86,540	89%

Figure 52: Percentage of documents in English and in German from Germany in the Web of Science 1970-2006

Figure 52 shows the percentage of documents in English and in German from Germany indexed in the Web of Science through 1965-2005.

The Figure indicates that the percentage of publications in English in the Web of Science from Germany has exponential increased; whereas the percentage of publication in German has exponential declined.

The percentage of publications in English from Germany has reached to the saturation level at 89% in 2004.

Table 14: US$ GDP per publication in the SCI and Web of Science 1991

Country	GDP per publication in SCI 1991	GDP per publication in WoS 1991	Percentage of publications in Social Science and Arts & Humanities
France	41,323,071	32,649,672	27%
Germany	44.946.165	34.489.160	29%
Japan	78,138,224	68,899,430	13%
Canada	21,997,316	15,511,279	42%

Italy	65,411,702	54,557,746	20%

The table indicates that only 13% of publications in Japan in 1991 were related to the social Science, Arts & Humanities Citation. In other words 87% of all publication in the Web of Science for Japan was related to the Science. It is clear that Japan published the most expensive publication among 5 countries in 1991.

Table. 15: US$ GDP per publication in the SCI and Web of Science 1999

Country	GDP per publication in SCI 1999	GDP per publication in WoS 1999	Percentage of publications in Social Science, Arts & Humanities
France	32,029,395	25,372,270	26%
Germany	34,036,313	26,645,216	28%
Japan	63,465,221	54,099,952	17%
Canada	20,272,975	14,427,562	41%
Italy	37,903,162	31,578,542	20%

Table 15 shows that the portion of publications in Social science and Art & Humanities Science from Canada in 1999 is 41% of all publications; whereas this portion from Japan is 17%. In other word Canada used to publish more publications in Social Science and Art & Humanities.

The cost of publications in Japan related to GDP in the SCI was 255% in 1991 and 213% in 1999 higher than in Canada.

Japan published more expensive publications than France, Germany, Canada and Italy related to GDP in the SCI and Web of Science in 1991 as well as in 1999. The number of publications in the Web of Science among countries excluded Canada was about 20% higher than in the SCI. It is clear that publications related to the Science reflect the innovation activities in the countries and also expects more money than in social science and Art & Humanities.

7.1 Results of section three:

Analysis of data showed that, the number of documents indexed as a topic of patents in the SCI from 1965 to 1990 rose slightly. Since 1991 it shows sharp growth, peaking in 2003.

The patent literature throughout the period of study overall had a doubling time of 8.8 years.

The number of patent literature in the Science Citation Index was higher than in MEDLINE. The growth of patent literature in MEDLINE since 1982 showed higher growth than in SCI. It indicates that scientists have engaged themselves more in medical fields in the last two decades.

The doubling time of patent literature in the SCI throughout the period of study is 8.8years, whereas the doubling time of patent literature in MEDLINE (PubMed) is 6.4 years.

From a total number of 7,056 authors with a total frequency of 9,043 times in the SCI, 5.06% of them were anonymous.

From a total of 19 kinds of publications type for documents indexed as patents (patent Literature) with a total frequency of 4,808 times throughout 1965-2005 in the SCI; Journals article with 58.74% of all publication was the most frequented publication type followed by editorial-materials with 10.50%, reviews with 9.26%, news-item with 5.49%, meeting-abstract with 5.28% and letters with 5.12%.

From a total of 1,448 kind of periodicals with a total frequency of 4,810 times, 6.49% were published in journal “*Expert Opinion on Therapeutic Patents*“, 3.80% in “*Abstracts of Papers of the American Chemical Society*”, 3.80% in *Nature* and 2.81% in *Biotechnology Law Report*.

English with 93.88% of all publication was the most frequented language of documents indexed as patents (patent Literature) in the SCI, followed by German with 2.56% and French with 1.79%.

The study further showed that, the percentage of English for patent Literature in the SCI is 4.16% higher than in MEDLINE (PubMed), and the percentage of Russian in MEDLINE is 3.90% higher than in the SCI.

In the SCI some records were found in Polish, Portuguese and Chinese, but such languages were not found in MEDLINE. In contrast there were records in Ukrainian, Norwegian, Bulgarian and Hungarian languages in MEDLINE; whereas there weree not such languages in the SCI.

The number of publications from Germany in the Web of Science showed a fall in 1989. Since 1990 there was a boom for the number of publications from Germany. The proportion of publications in German from Germany indexed in the Web of Science showed continuously decline throughout the period of study; whereas the percentage of publications in English increased.

The number of total publications from France in spite of a fall in 1989 has steady increased in the Web of Science throughout 1965-2005. Evidently the fall of publications for France in 1989 was due to the fall of publications in French language. In the meanwhile the number of publication in English for France enjoyed a steady growth throughout 1970-2005.

The fall of the Berlin Wall didn’t have negative impact on the German publications in the Web of Science. The reason is that: After 1989 Germany enjoyed an increasing trend of publications in the Web of Science. The proportion of publications in French for France decreased roughly sharp since 1989, but the proportion of publications in English for France enjoyed relatively a sharp growth since 1989 in the Web of Science.

8 Section four: Analysis of cited references

This section depicts the analysis of cited patents, cited references for patent-citing documents and general scientific documents (randomly chosen documents) in the Science Citation Index. The number and the origin of cited patents are determined. The trends for half-life[118] of citations to the patent documents and general scientific documents in the SCI are verified. The number of citation classics[119] among citations to the patent documents and as well in general scientific documents, and the mean value and the mode (maximum number) of cited references per paper are distinguished.

An effective way to evaluate the impact of scientific output is to count the frequency of the appearance of citations to references of publications. "There is a significant correlation between journal productivity and citation frequency."[120]

"The use of public science by firms can be documented in the number of references to scientific publications in patents and vice versa."[121]

The higher an invention's economic value estimate is, the more the relevant patent is subsequently cited. [122]"Of course publication and citation counts are only some measure of

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118 Determining of half-life in the years 1994-1999.

119 A Citation Classic is a highly cited publication as identified by the Science Citation Index (SCI) the Social Sciences Citation Index (SSCI), or the Arts & Humanities Citation Index (A&HCI). Citation rates differ for each discipline. The number of citations indicating a classic in botany, a small field, might be lower than the number required to make a classic in a large field like biochemistry. In general, a publication cited more than 400 times should be considered a classic; but in some fields with fewer researchers, 100 citations might qualify a work (source: http://www.garfield.library.upenn.edu/classics.html).

120 Tsay, Ming-Yueh and Ma, Shiao-Shing (2003). The nature and relationship between the productivity of journals and their citations in semiconductor literature., Scientometrics, Vol. 56, No.2,p. 201-222.

121 Debackere, Koenraad and Veugelers, Reinhilde (2005). The role of academic technology transfer organizations in improving industry science links, Research policy, Vol. 34, P. 321-342. Retrieved December 15, 2006 from http://www.sciencedirect.com/science?_ob=MImg&_imagekey=B6V77-4G05M6H-1-3&_cdi=5835&_user=964000&_orig=na&_coverDate=04%2F30%2F2005&_sk=999659996&view=c&_rdoc=1&wchp=dGLbVlz-zSkWW&md5=978ecdb93e1685fa94c00d5aea4c4fdd&ie=/sdarticle.pdf

122 Harhoff, Dietmar; Narin Francis; Scherer Frederic M. and Vopel, Katrin(1997). Citation frequency and the value of patented innovation. Retrieved November 17, 2006 from: http://skylla.wz-berlin.de/pdf/1997/iv97-26.pdf#search=%22Citation%20frequency%20and%20the%20value%20of%20patented%20innovation%22.

research performance and must be used carefully-specially at the level of an individual's record where the numbers may be quite small."[123] The impact of scientific publication is often estimated by how frequently they are referenced by other publications. This technique provides insight on both emerging and obsolete research areas. "Another growth indicator within the literature is the increase in the average number of references contained in a typical article."[124]

With increasing completion and specialization in the academic field, citations are increasingly used as indicators of individual or departmental activity.[125]

"Decision on firing and hiring in academia and the funding of departments are increasingly based on rankings, publication and citation records. The refined division of labour in academia has made it quite difficult to assess the quality of researchers or departments. Deans, administrators, sometimes even colleagues are unable to appreciate the content of research and the only lead to follow are external judgements like citations, publications in refereed journals and prizes. "The number of such signals has increased tremendously as internet technology allows publishers and others to generate numerous statistics to assess a contribution in science."[126]"Of course the quality of articles differs enormously across the entire spectrum of scholar if one takes the number citations as an approximation of the quality of an article."[127]

Investigation of the citation trends, either citing publications (mentioning of earlier publications in later publications) or cited publications or references (the listing of earlier publications mentioned by in the later publications, is of great use, in order to determine the

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[123] Garfield, Eugene (1995). Quantitative analysis of the scientific literature and its implications for science policymaking in Latin America and the Caribbean, Bulletin of the pan American health organization-special report, Vol. 29, No.1, P. 87-95, Retrieved November 24, 2006 from http://www.garfield.library.upenn.edu/papers/paho29(1)p87y1995.pdf#search=%22quantitative%20analysis%20of%20the%20scientific%20literature%22.

[124] Garfield, Eugene. (1979-80), Essays of an Information Scientist, Vol. 4, p. 419-425. Retrieved December 24, 2006 from www.garfield.library.upenn.edu/essays/v4p419y1979-80.pdf

[125] Hargens, L. L.; Schuman H. (1990). Citation counts and social comparisons: scientists. Use and evaluation of Citation Index Data, Social Science Research, Vol. 19, p. 205-221.

[126] Vandalen, Hendrik P., and Henkens, Kene (2005). Signals in science. On the importance of signalling in gaining attention in science, Scientometrics, Vol. 64, No. 2, p. 209-233. Retrieved November 29, 2007 from http://www.nidi.knaw.nl/en/output/2004/ti-discussion-2004-113-1.pdf/ti-discussion-2004-113-1.pdf

[127] Klamer,, Arjo and Van Dalen, Hendrik P. (2002), Attention and the art of scientific publishing, journal of economic methodology, vol.9,No. 3, p. 289-315.

effect or impact of scientific output on certain scientific information areas, and also the impact of publications, as an important research method.

Citation analysis is a well-established method to determine which sources have been used heavily after their emergence in publications. Citation counts are used as an objective measure of the importance and usefulness of papers.

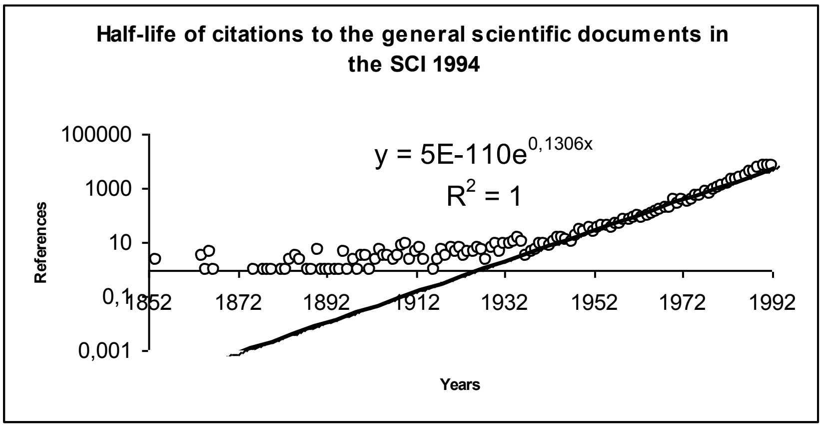


Figure 53: Half-life of citations to the general scientific documents in the SCI 1994

Figure 53 illustrates that the half-life of citations to the general scientific documents in the e-function from 1941 to 1992 is 5.30 years ($t_{½}$ = 5.30 y) and the difference in the time before, due to the citation classics, is 0.08% of all values.

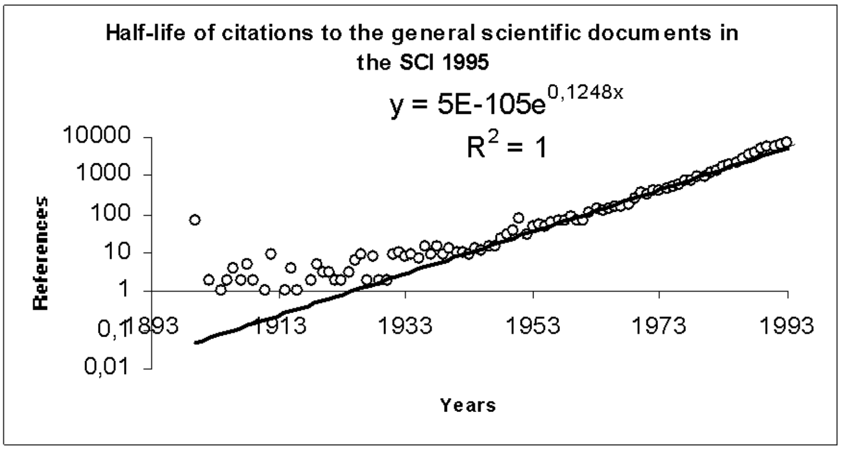


Figure 54: Half-life of citations to the general scientific documents in the SCI 1995

Based on Figure 54 the half-life of citations to the general scientific documents in the SCI in the e-function from 1941 to 1993 is 5.55 years ($t_{½}$ = 5.55 y) and the deviation in the time before, due to the citation classics, is 0.34% of all values.

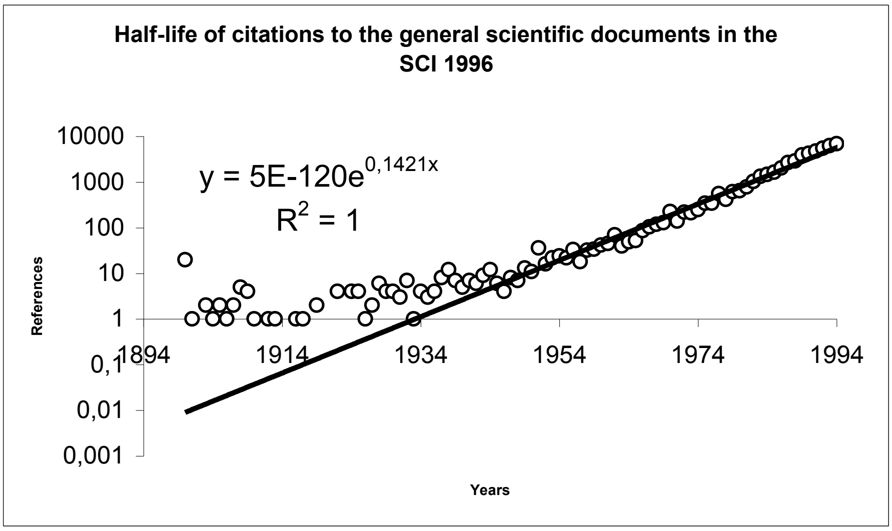


Figure 55: Half-life of citations to the general scientific documents in the SCI 1996

The half-life of citations to the general scientific documents in the SCI in the e-function from 1941 to 1994 is 4.78 years ($t_{½}$ = 4.87 y) and the deviation in the time before, due to the citation classics, is 0.19% of all values.

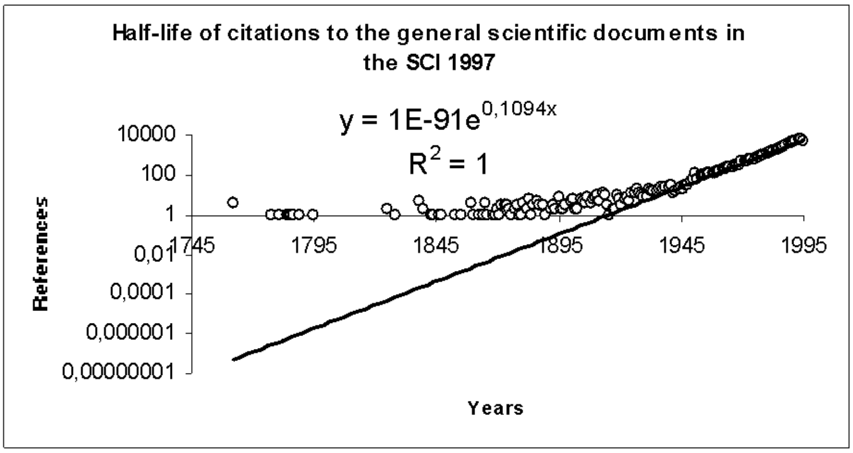


Figure 56: Half-life of citations to the general scientific documents in the SCI 1997

Based on Figure 56, the half-life of citations to the general scientific documents in the SCI, in the e-function from 1941 to 1995 is 6.33 years ($t_{½}$ = 6.33 y) and the deviation in the time before, due to the citation classics, is 0.47% of all values.

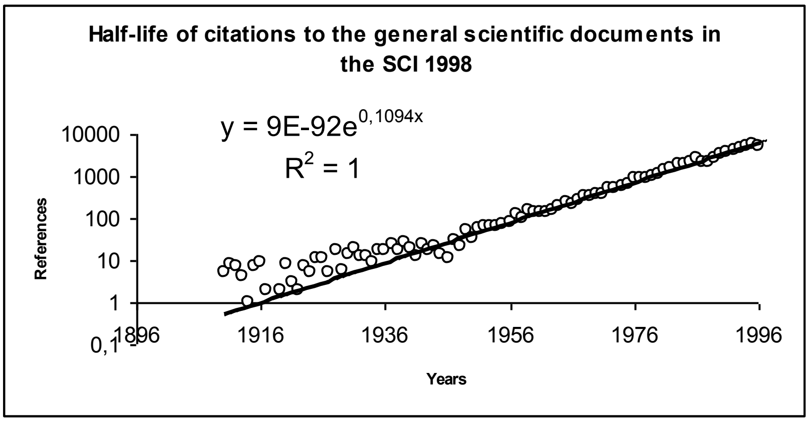


Figure 57: Half-life of citations to the general scientific documents in the SCI 1998

Based on Figure 57, the half-life of general scientific documents in the SCI, in the e-function from 1941 to 1996 is 6.33 years ($t_{½}$ = 6.33 y) and the deviation in the time before, due to the citation classics, is 0.24% of all values.

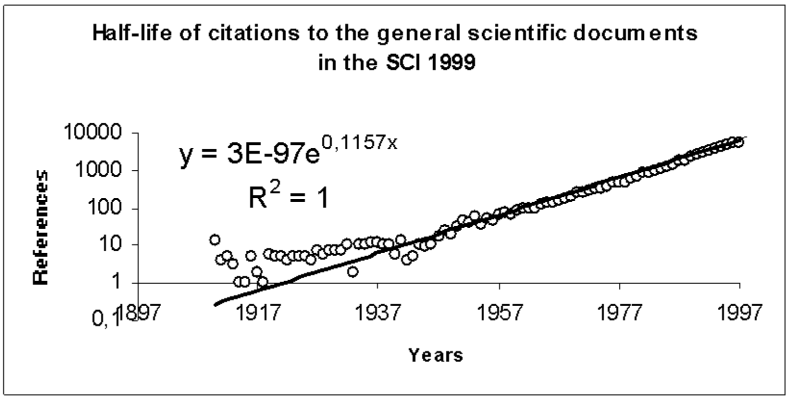


Figure 58: Half-life of citations to the general scientific documents in the SCI 1999

As Figure 58 illustrates, the half-life of general scientific documents in the SCI, in the e-function from 1941 to 1997 is 6 years ($t_{½}$ = 6 y) and the deviation in the time before, due to the citation classics, is 0.2% of all values.

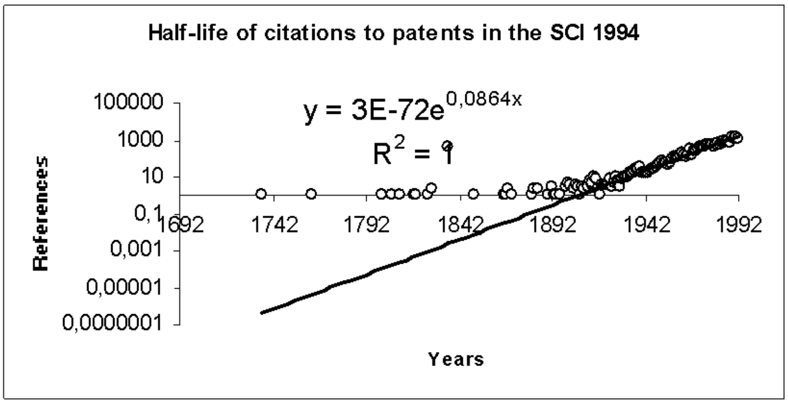


Figure 59: Half-life of citations to patents in the SCI 1994

As Figure 59 shows, the half-life of citations to patents in the e-function from 1941 to 1992 is 8.02 years ($t_{½} = 8.02$ y) and the deviation in the time before, due to the citation classics, is 1% of all values.

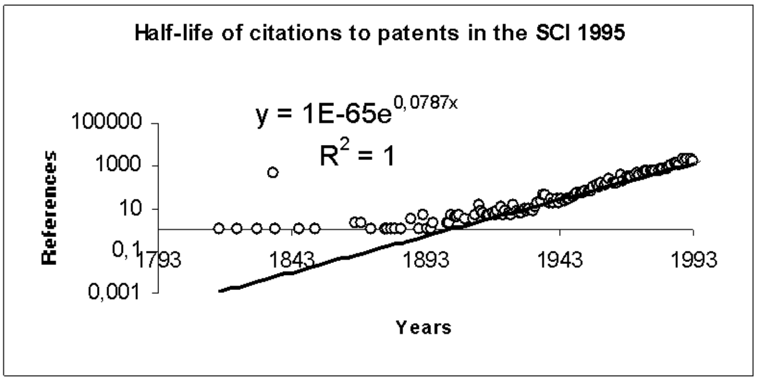


Figure 60: Half-life of citations to patents in the SCI 1995

Based on Figure 60, the half-life of citations to patents in the e-function from 1941 to 1993 is 8.8 years ($t_{½} = 8.8$ y) and the deviation in the time before, due to the citation classics, is 3% of all values.

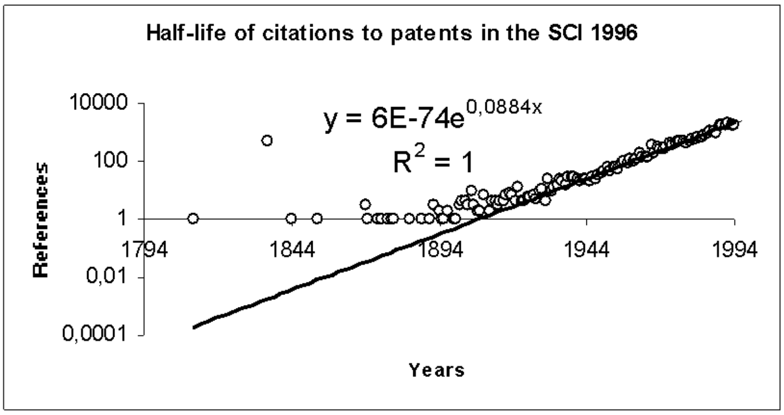


Figure 61: Half-life of citations to patents in the SCI 1996

Based on Figure 61, the half-life of citations to patents in the e-function from 1941 to 1994 is 7.48 years ($t_{½}$ = 7.48 y) and the deviation in the time before, due to the citation classics, is 2% of all values.

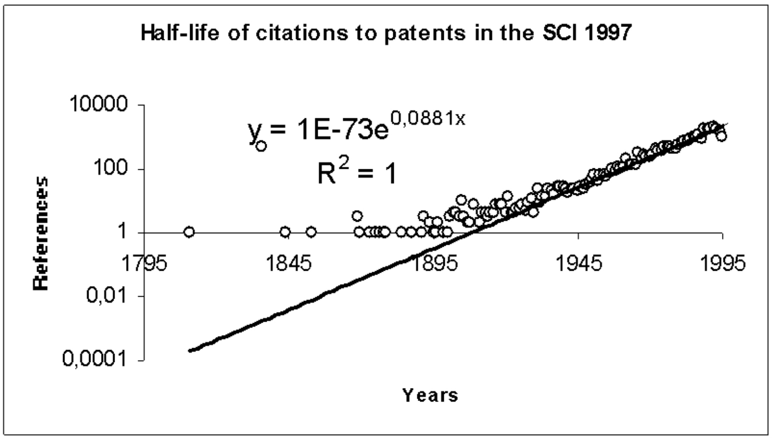


Figure 62: Half-life of citations to patents in the SCI (1997)

As Figure 62 shows, the half-life of citations to patents in the e-function from 1941 to 1995 is 7.87 years ($t_{½}$ = 7.87 y) and the deviation in the time before, due to the citation classics, is 2.2% of all values.

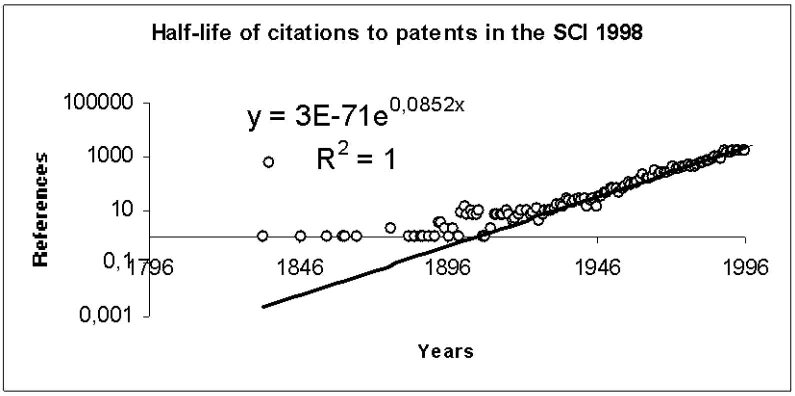


Figure 63: half-life of citations to patents in the SCI 1998

As Figure 63 shows, the half-life of citations to patents in the e-function from 1941 to 1996 is 8.13 years ($t_{½}$ = 8.13 y) and the deviation in the time before, due to the citation classics, is 2.15% of all values.

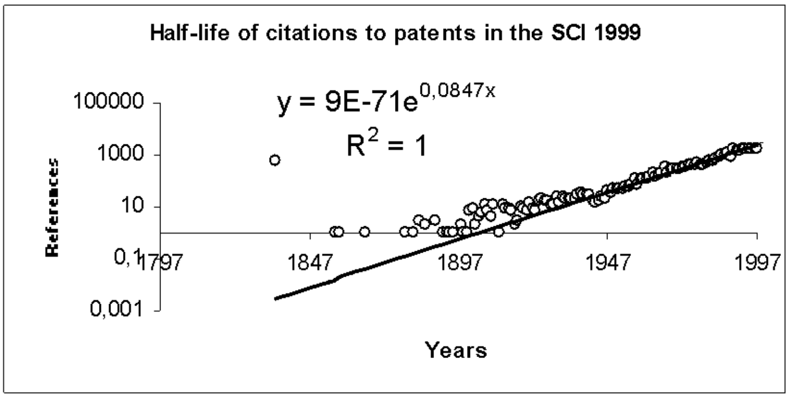


Figure 64: Half-life of citations to patents in the SCI (1999)

As Figure 64 illustrates, the half-life of citations to patents in the e-function from 1941 to 1997 is 8.18 years ($t_{½}$ = 8.18 y) and the deviation in the time before, due to the citation classics, is 2.4% of all values.

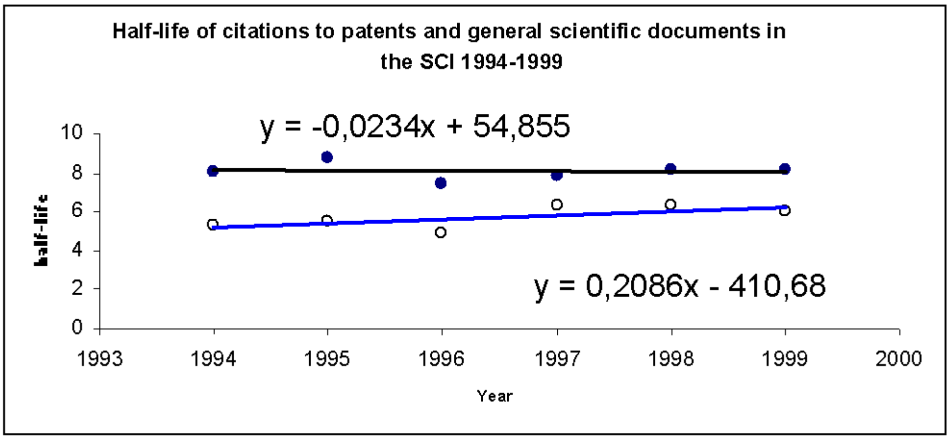


Figure 65: Half-life of citations to patents and general scientific documents (randomized chosen documents) in the SCI 1994-1999

As Figure 65 illustrates, the half-life of citations to patents (○) in the SCI is higher (41%) than the half-life of citations to the general scientific documents (●) throughout 1994-1999. It means that documents in context with patents were cited for longer times than general scientific documents in the SCI. The graph indicates relatively constant trend for citations to patents throughout 1994-1999, but there is a fluctuation for the trend of citations to general scientific documents.

Table 16: Comparison of half-life of citations to patents with general scientific documents (randomized chosen documents) and Citation Classics in the SCI 1994-1999

Years	Half-life of citations to patents in the SCI	Half-life of citations to the general scientific documents In the SCI	% of Citation Classics used as references for the patent citing documents in the SCI	% of Citation Classics used as references for general scientific documents in the SCI
1994	8.02	5.30	1	0.08
1995	8.8	5.55	3	0.34
1996	7.48	4.87	2	0.19
1997	7.87	6.33	2	0.47

1998	8.13	6.33	2	0.24
1999	8.18	6	2	0.20
Mean value	**8.1**	**5.73**	**2**	**0.25**

As table 16 illustrates, the half-life of citations to patents is 41% higher than the half-life of citations to the general scientific documents (randomly chosen documents) in the SCI throughout the period of study. The mean value of half-life of citations to patents is 8.1 years and the mean value of half-life of citations to the general scientific documents is 5.73 year in the SCI through 1994-1999.

The portion of citation classics used in the references of patent-citing documents is 8 times higher than the citation classics of general scientific documents. The mean value of the portion of citation classics for patent citing documents through 1994-1999 is 2%, whereas the mean value of the portion of citation classics for randomized chosen documents in the SCI is 0.25%.

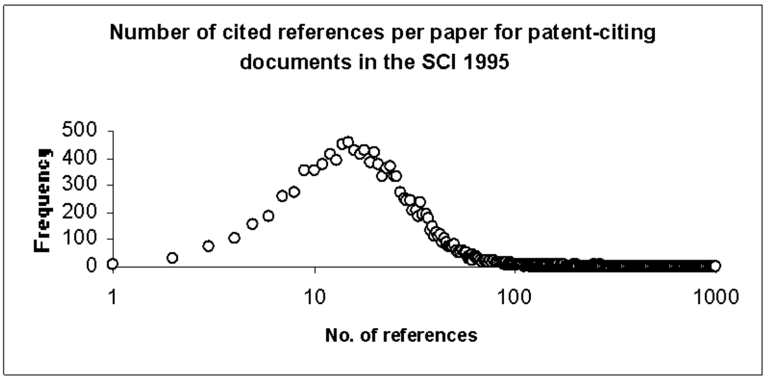


Figure 66: Number of cited references per paper in the SCI for documents that cited at least one patent document 1995

Figure 66 shows the number of cited references per paper for the publications, those cited at least to one patent in 1995. The log-normal distribution for references among the patent-documents cited as references from 1995 has a mode of 16 citations throughout the period. The documents contain at least 1 reference to a patent document.

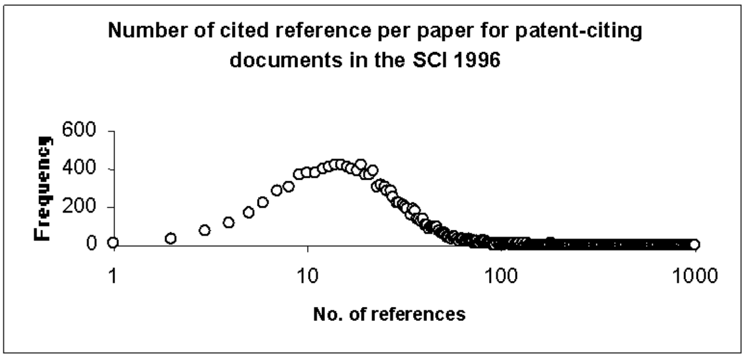


Figure 67: Number of cited reference per paper in the SCI for documents that cited at least one patent 1996

Figure 67 shows the number of cited references per paper for the publications, those cited at least one patent document in the SCI in 1996. As the Figure indicates the log-normal distribution for the patent-citing documents in 1996 in the SCI, shows with a maximum distribution (mode) of 14. The documents contain at least 1 reference to a patent.

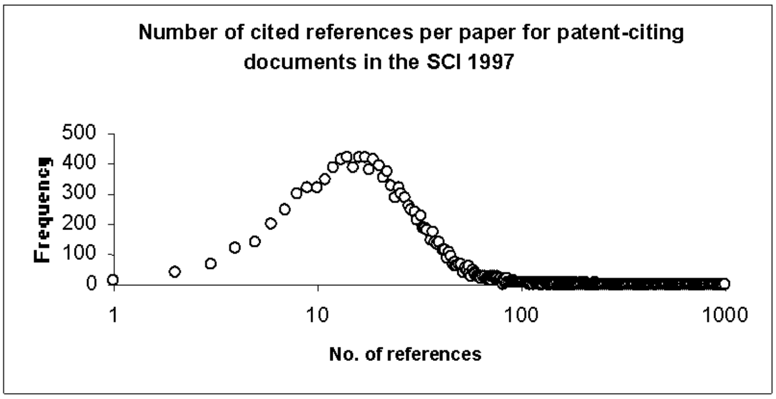


Figure 68: Number of cited reference per paper for patent citing documents (documents that cited at least one patent document) in the SCI in 1997

Figure 68 shows the number of cited references per paper for the publications, those cited at least one patent document in the SCI in1997.The Figure indicates that the log-normal distribution for the references among patent-citing documents in the SCI in 1997 has a maximum distribution (mode) of 15 citations. The documents contain at least 1 reference to a patent.

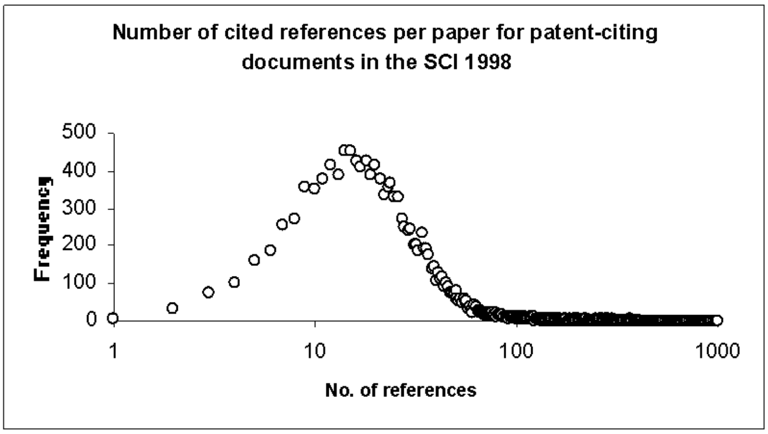


Figure 69: Number of cited references per paper for patent-citing documents in the SCI in 1998

Figure 69 shows the number of cited references per paper for the publications in the SCI in 1998. Those cited at least one patent document. Based on the Figure, the log-normal distribution for the references among patent references has a maximum distribution (mode) of 16. The documents contain at least 1 reference to a patent.

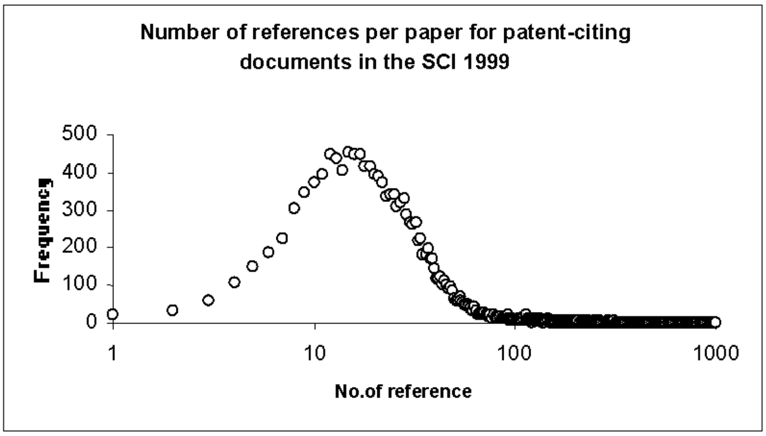


Figure 70: Number of cited references per paper for patent-citing documents in the SCI 1999

Figure 70 shows the number of cited references per paper for the publications in the SCI in 1998. Those cited at least one patent document.

The Figure illustrates that the log-normal distribution for the references in patent citing documents in 1999 had a maximum distribution (mode) of 14. The documents contain at least 1 reference to a patent document.

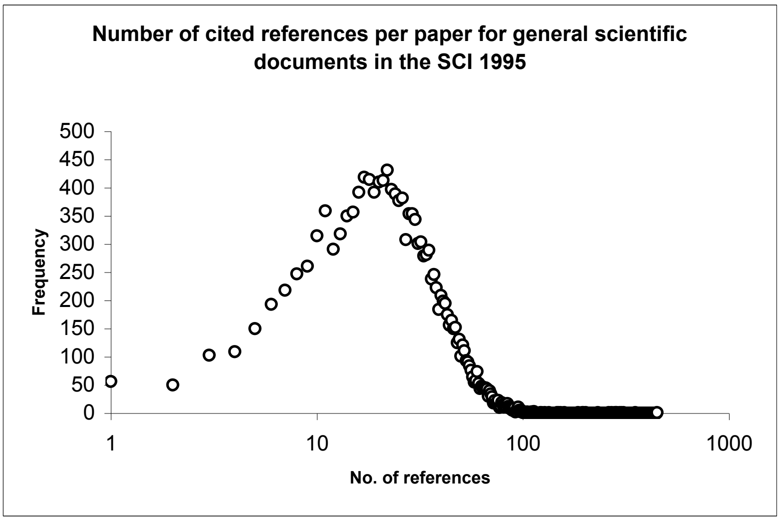


Figure 71: Number of cited references per paper for general scientific document (randomized chosen documents) in the SCI 1995

Figure 71 shows the number of cited references per paper for the randomly chosen documents in the SCI in 1995. As the log-normal distribution for the general scientific documents (randomized chosen documents) from 1995 shows, it has a maximum distribution (mode) of 19. The documents were without any citation to the patent documents. A total of 15,000 documents were randomly chosen in the SCI in 1995. Those containing patent-cited references were omitted, leaving the documents with yet a total of 430 996 citations for that year.

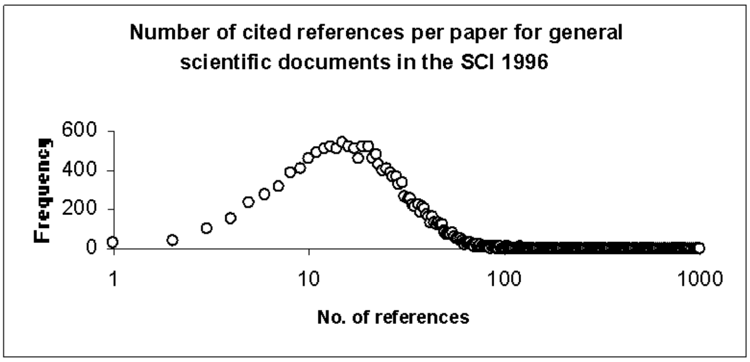


Figure 72: Number of cited references per paper for general scientific documents in the SCI 1996

As Figure 72 shows, the log-normal distribution for the randomized chosen documents in 1996 had a maximum distribution (mode) of 16 cited references with a mean value of 25.75. These documents were without any cited references to the patent documents. A total of 15,000 documents were randomly chosen from the SCI in 1996 and the patent-cited documents were omitted, the remaining citations total 386,216 in this year.

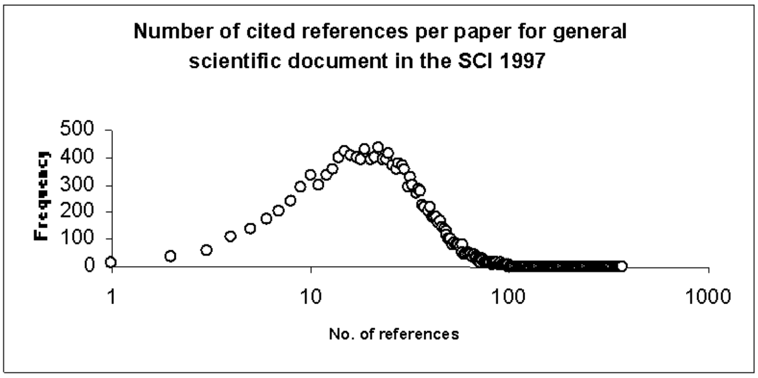


Figure 73: Number of cited references per paper for general scientific documents in the SCI 1997

As the log-normal distribution in Figure 73 for the randomly chosen documents in the SCI from 1997 shows, it had a maximum distribution (mode) of 19 citations. The documents were without any citation to the patent document. A total number of 15,000 documents were randomly chosen from the SCI in 1997, the patent-citing documents were omitted, and the remaining citations total 432,215 in this year.

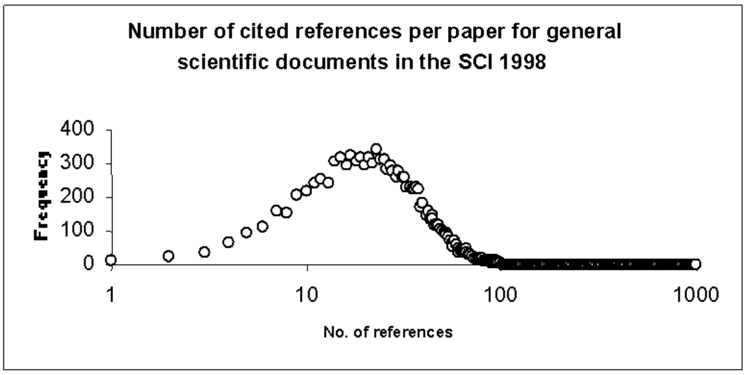


Figure 74: Number of cited references per paper for randomized chosen documents in the SCI 1998

As the log-normal distribution for the randomized chosen references in the SCI from 1998 shows, it had a maximum distribution (mode) of 21 citations. The documents were without any patent citation. A total number of 15,000 documents were randomly chosen from the SCI in 1998 and the patent-citation documents were omitted, the remaining citations total 458,640 in this year.

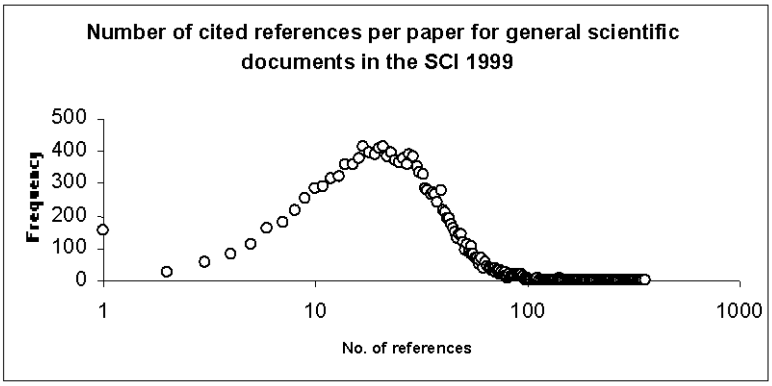


Figure 75: Number of cited reference per paper for randomized chosen documents in the SCI 1999

Figure 75 shows the number of cited references per paper for the randomly chosen documents in the SCI in 1999.

As the log-normal distribution for the randomly chosen references from 1999 shows, it had a maximum distribution (mode) of 21 citations.

The documents were without any patent citation. A total of 15,000 documents were randomly chosen from SCI in 1999 and the patent-cited documents were omitted, the remaining citations total 449,264 in this year.

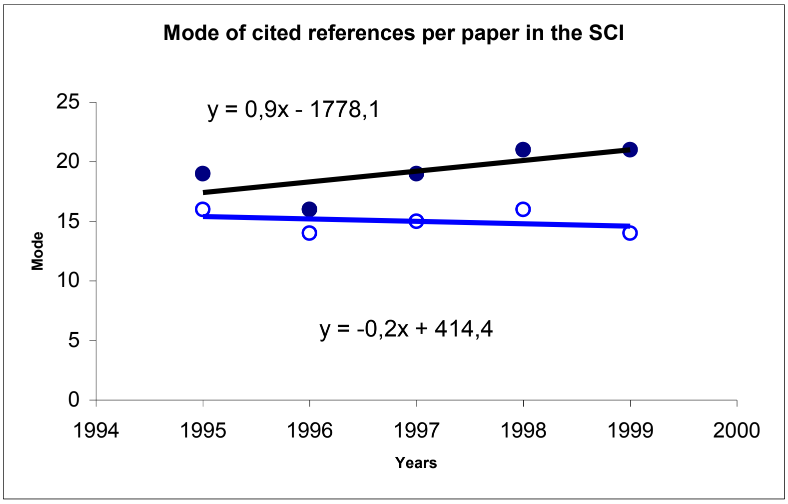


Figure 76: Maximum log-normal of cited references per paper for patent-citing documents and general scientific documents in the SCI. 1995-1999

As Figure 76 illustrates, the maximum distribution (mode) of cited references per paper for patent-citing documents (○) during 1994-1999 were lower (13%) than those that had no citation to the patent documents (●). The mean value of the maximum distribution (mode) of cited references per paper for patent-citing documents was 15 and the mean value of the maximum distribution (mode) of cited references per paper for general scientific documents was 17. The maximum distribution (mode) of cited references per paper for patent-citing documents throughout the period of study was roughly stable but the maximum distribution of cited references per paper for randomly chosen documents (non patent-citing documents) showed a fluctuation throughout the period.

Table 17: The frequency of records, cited references and mean value of cited references per paper for patent-citing documents in the SCI 1995-1999

Years	No. of cited references for patent-citing documents	No. of Records	Mean value of cited references	Mode
1995	464,846	13,473	34.50	16
1996	424,840	12,957	32.78	14
1997	429,327	12,886	33.31	15
1998	464,846	13,475	34.49	16
1999	497,264	14,247	34.90	14
Total	2,281,123	67,038	34.02	15

As table 17 shows, there were 67,038 records that had at least one citation to the patents through 1995-1999. These records account for over 2,281,123 cited references. The mean value of cited references is 34.02 throughout the period. The most frequented number of cited references (mode of cited references) is 15 citations.

Materials in the patent-citing documents in the SCI throughout the period were cited back as far as 1561, and the number of citations ranged from a low of one to a high of 1,842 and averaged 34.02 cited references for each documents. The documents contain review articles too. Analysis of this study indicated that the mean value of cited references per paper is higher than the previous related studies[128].

Table 18: Comparison of patent documents cited among non-patent documents in the SCI 1995-1999

Years	Non-patent documents used as cited references among cited-patents	No. of cited-patents	% Non-patent documents used as cited references among cited-patents	% No. of cited-patents
1995	437,296	27,550	19%	1%
1996	395,114	29,726	17%	1%
1997	399,469	29,858	18%	1%
1998	434,467	30,379	19%	1%
1999	462,520	34,744	20%	2%
total	2,128,866	152,257	93%	7%

[128]Garfield, E. in the "Essays of information scientists. Vol. 2, p.419-425, (1974-1976) " announced that, the average chemistry or physics articles, contain about twenty references, while math article contain less than ten. Disregarding language and discipline, the average article in 1974 contained thirteen (13) references. The average article in a journal published in France contained 8.8 references.
In another study "Essays of an Information Scientist, Vol. 4, p. 419-425" in 1980 Garfield, E. found out that the average number of references in biochemical journals during 1962-1977 increased from a mean value of 18.2 to 26.1 references with 43% increase (18.2 to 26.1) from 1962 to 1977. In the same study he found that the average number of references in SCI throughout 1968-1977 increased from 12.0 to 13.5 references. Some of the difference in this study can be explained by the fact that the SCI data base covers a substantial number of items such as letters and abstracts. These items are not as likely to appear in the core biochemistry journals, which tend to publish full research articles almost exclusively.
Another study by Solar Álvarez et al about the bibliometric indicators of the research on epidemiology and healthcare published in Spain between 1988 and 1992 showed that the mean number of references per article was 24.4.
José Ignacio de Granda-Orive and et al in 2004 in a study "the Evolution of Bibliometric Indicators And His Websites Evaluation Approaches In Relation To The Foremost Respiratory Journal In Spanish" found out that the mean number of references for all article was 18 ± 20.

As table 18 shows, only 7% of total cited references among citations to the patents were citations to the patents and 93% of them were general scientific documents (non-patent documents).

Table 19: The frequency of records, number of references and the mean value of references per paper for general scientific documents (randomized chosen) in the SCI during 1995-1999

Years	No. of cited references for randomized chosen documents in SCI	No. of Records	Mean value of cited references per paper	Mode of cited references per paper
1995	430,996	15,000	28.73	19
1996	386,216	15,000	25.75	16
1997	432,215	15,000	28.81	19
1998	458,640	15,000	30.58	21
1999	449,264	15,000	29.95	21
Total	**2,157,331**	**75,000**	**28.76**	**17**

As table 19 shows, 75,000 records[129] were randomly chosen through 1995-1999 from the SCI. There were 2,157,331 cited references for these documents (all patent-cited references were omitted). The mean value of cited references per paper for each year throughout the period was 28.76 with a mode (maximum number of references) of 17 references. Materials in the randomly chosen documents in the SCI throughout the period were cited back as far as 1736. The number of cited references ranged from zero to a high of 1,113 and averaged 28.76 cited references per documents.

Comparison of table 17 with table 19 indicates that the mean value of references per paper among patent-citing documents is 18% higher than the mean value of references per paper for

[129] The records contain review articles too.

general scientific documents in the SCI throughout 1995-1999. In other words, the patent-citing authors tend to cite more references in their works.

If we look in the SCI from 1970 to 2005 in randomised samples of 10,000 records for the number of references, we see a clear multiplication of references per paper (table 19).

Table 20: Mean value of cited references per paper for general scientific documents in the SCI through 1970-2005

Years	No. of Records	No. of cited references for randomized chosen documents	Mean value
1970	10,000	84,045	8.40
1975	10,000	106,858	10.68
1980	10,000	150,194	15.01
1985	10,000	161,389	16.13
1990	10,000	215,993	21.59
1995	10,000	287,330	28.73
2000	10,000	319,074	31.90
2005	10,000	346,320	34.63

The total numbers of cited references for randomly chosen documents in the SCI for the years under study are plotted in table 20. It shows a steady increase from the year 1970 to 2005.

Comparing the mean values of cited references per paper for years 1970 and 2005 shows an Increase of more than 4 times; the mean value of references per paper from 1970 to 2005 has increase from 8.40 to 34.63.

Table 21: The language of documents (randomly chosen documents from the SCI (1970-1975-1980-1985-1990)

No.	language	Frequency	percent
1	English	46,769	93.54
2	Russian	1,076	2.15
3	French	854	1.71
4	German	761	1.52
5	Spanish	124	0.25
6	Japanese	87	0.17
7	Italian	66	0.13
8	Swedish	46	0.09
9	Dutch	44	0.09
10	Czech	41	0.08
11	Norwegian	36	0.07
12	Polish	35	0.07
13	Chinese	22	0.04
14	Ukrainian	16	0.03
15	Finnish	7	0.01
16	Hungarian	6	0.01
17	Afrikaans	3	0.01
18	Danish	3	0.01
19	Portuguese	3	0.01
20	Slovene	1	0.00
Total		50,000	100.00

Table 21 plots the frequency of languages for randomly chosen document in the SCI. it indicates that more than 93% of documents indexed in the SCI were in English.

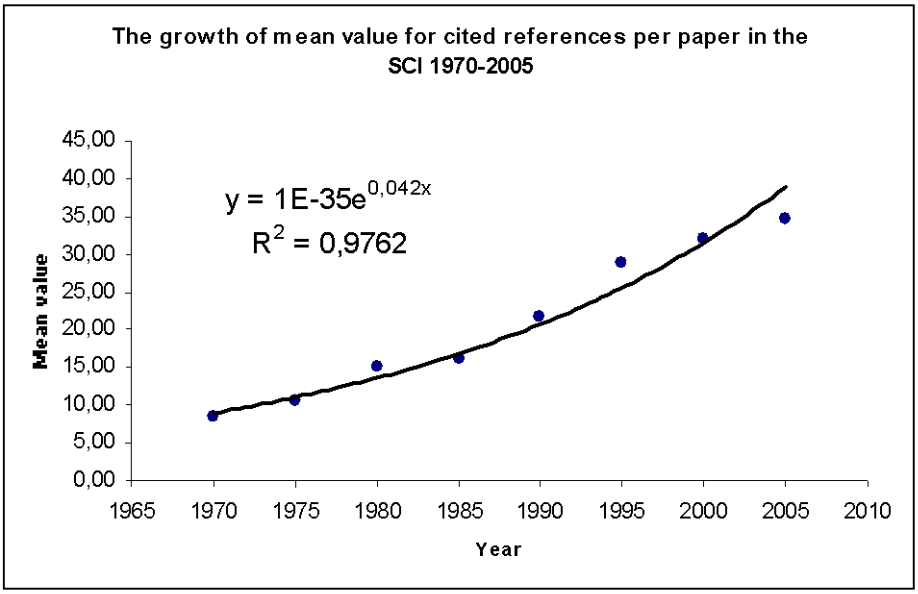


Figure 77: The growth of mean value for cited references per paper in the SCI 1970-2005

Figure 77 shows the growth of mean value for cited references per paper for general scientific documents in the Science Citation Index from 1970 to 2005.As Figure illustrates there is a high correlation between the numbers of cited references per paper and the year of under study. They show a steady increase with a 4 times higher value in 2005 in relation to 1970. With other words, the number of cited references per paper in the SCI is growing by 4 references in 5 years constantly.

The mean value of references per paper through the period of study shows a doubling time of 16.5 years.

Table 22: Distribution of patent-citing documents in the SCI 1995-1999

Publication type	Frequency	percent
Article	59,998	91
Review	4,522	7
Note	778	1

Letter	726	1
Editorial-Material	162	0
Meeting-Abstract	34	0
Reprint	28	0
Correction	28	0
News-Item	9	0
Biographical-Item	5	0
Discussion	3	0
Total	66,154	100

Table 22 maps the frequency and percentage of publications type, those cited to patent documents (patent-citing documents). The table indicates that more than 90% of all patent-citing documents in the SCI through 1995-1999 were in the form of articles. Publications in the form of Review consisted 7% of all documents. This is 4.3 times higher than the percentage of publications type in the form of Review for general scientific documents. It means that in comparison to the general scientific documents, patents were cited in higher rate by the publications in the form of Reviews. The rest (Notes and letters) consisted of only 1%.

Table 23: Distribution of documents type for cited references of general scientific documents the SCI 1970-1975-1980-1985-1990

Publication type of randomized chosen documents in the SCI 1970-1975-1980-1985-1990	Frequency	Percent
Article	34,222	68.44
Meeting-Abstract	7,064	14.13
Editorial-Material	2,493	4.99
Note	2,692	5.38

Letter	2,310	4.62
Review	820	1.64
Discussion	185	0.37
Correction-Addition	116	0.23
Abstract of published item	51	0.10
Item about an individual	36	0.07
Biographical-Item	11	0.02
Total	50,000	100.00

As table 23 illustrates, a total of 10,000 documents were randomly chosen for each year of study. Table shows that, more than 68% of general scientific documents (randomly chosen documents) in the SCI were in the form of articles, 14.13% were in the form of meeting-abstract, 4.99% in the form of editorial-material, 5.38% in the form of note, and only 1.64% of them were in the form of reviews. The other publications type were discussion, correction-addition, abstract of published item, item about an individual, and bibliographical-item which totally consisted 0.77% of all documents.

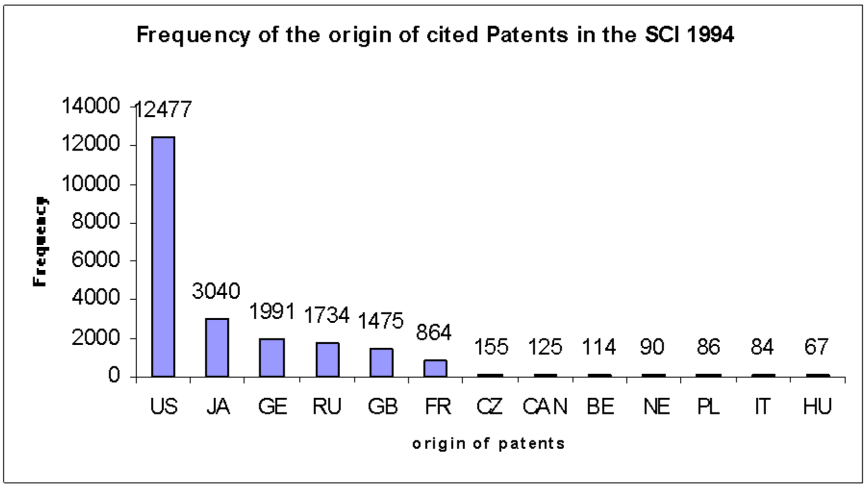


Figure 78: Frequency of the origin of cited Patents in the SCI 1994

As Figure 78 illustrates, from a total of 23,164 cited patents in 1994, about 54% (12,477) are USPTO patents, 13% Japan's patents, 9% (1,991) GE patents and 7% (1,734) Russian patents. The graph is restricted to the 13 most frequented patents origins.

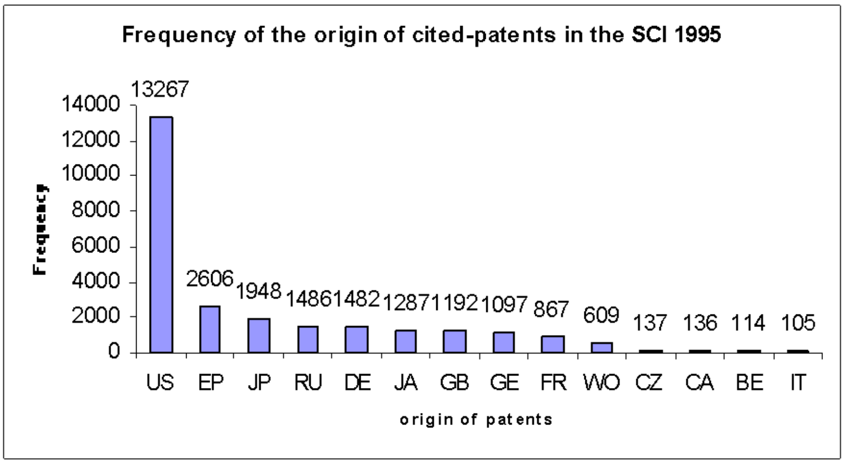


Figure 79: Frequency of the origin of cited-patents in the SCI (1995)

Figure 79 shows that 48% (13,267) of all cited patents in 1995 belonged to the USPTO, 9.5% (2,606) belonged to European patent office, 7% (1,948) were Japan's patents and 5% were Russian and German Patents.

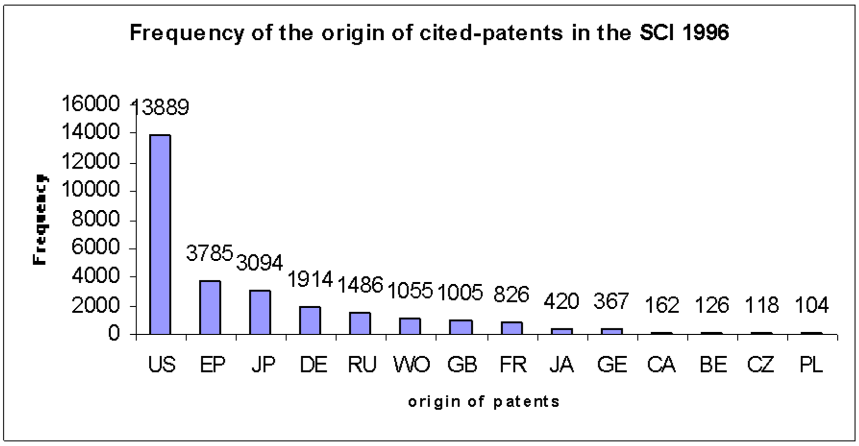


Figure 80: Frequency of the origin of cited-patents in SCI (1996)

As Figure 80 illustrates from total 29,726 of all cited patents in 1996 about 47% (13,889) are USPTO patents, 13% European patents, 10% Japan's patents, 6% German patents, and 4% are Russian patents.

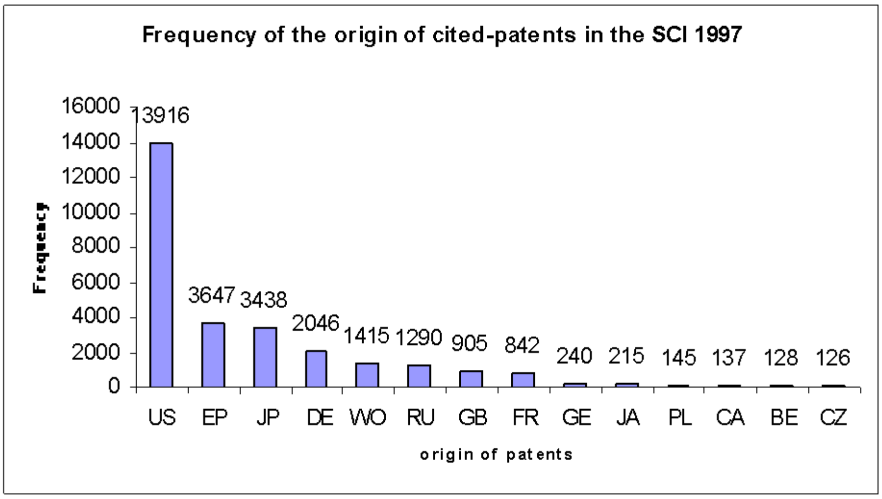


Figure 81: Frequency of the origin of cited-patents in the SCI (1997)

As Figure 81 shows, from total 29,858 cited patents in 1997, about 47% were USPTO, 12% were European patents, 12% Japan's patents and 7% were German patents.

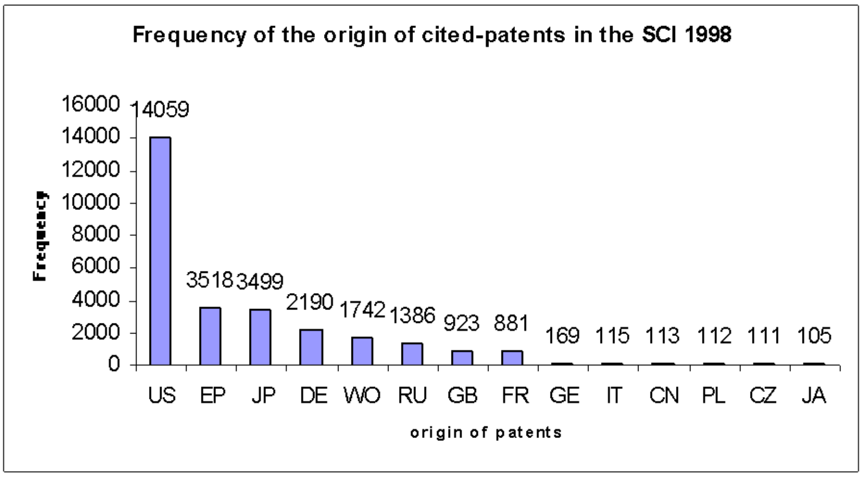


Figure 82: Frequency of the origin of cited-patents in SCI (1998)

As Figure 82 shows, from total 30,379 cited patents in 1998, about 46% of all them belong to USPTO, 12% to European patent office, 12% to Japan, 6% to world intellectual property organisation, and 4% are Russian patents.

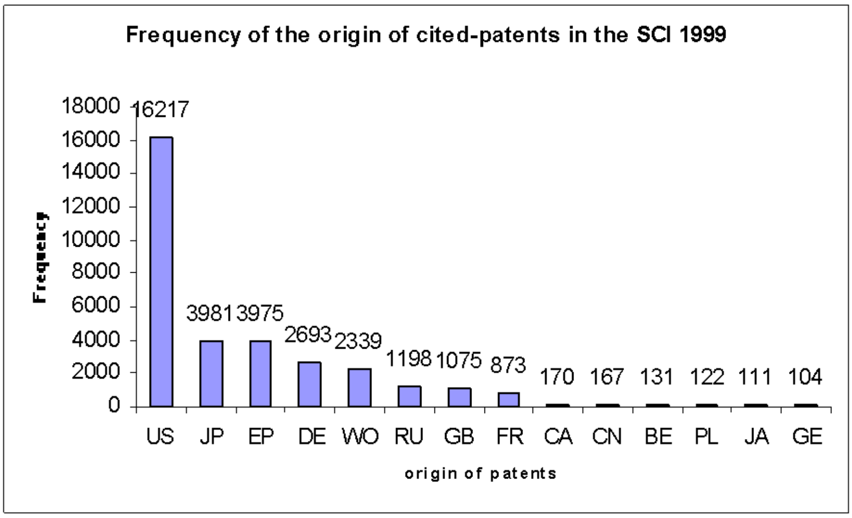


Figure 83: Frequency of the origin of cited-patents in the SCI (1999)

As Figure 83 shows, from total 34,744 cited patents in 1999, about 47% belong to USPTO, 11% to Japan, 11% to European patent office, 8% to Germany, 7% to WO (world intellectual property organisation), and 3% to Russia.

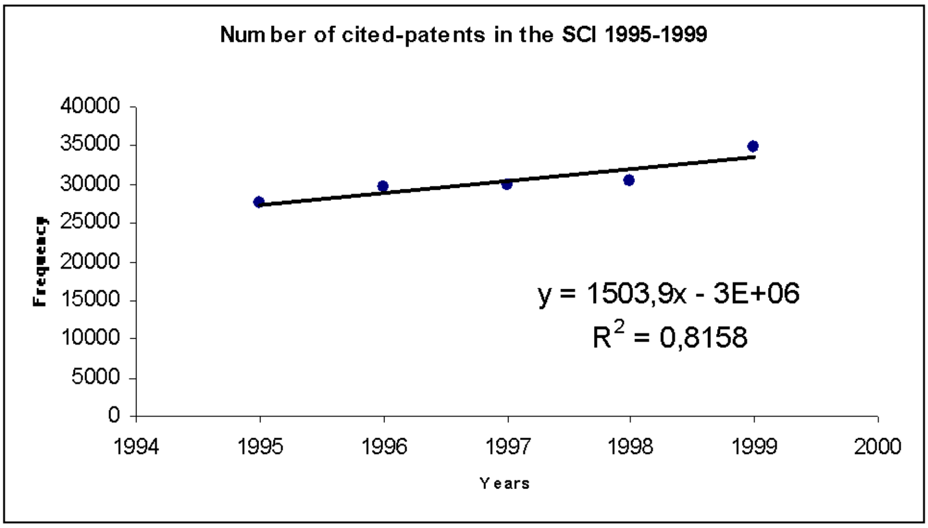


Figure 84: Number of cited patents in the SCI 1995-1999

Based on Figure 84, from total 152,258 cited patents through 1995-1999 in the SCI, 27,551 (18%) was cited in 1995, 29,726 (20%) in 1996, (29,858) 20% in 1997, 30,379 (20%) in

1998, and 34,744 (23%) in 1999. In other words, the patent citing activity shows relatively slight growth throughout the period of study. Citations to the patent documents showed a doubling time of 14 years in the SCI through 1995-1999.

The graph indicates that there is a linear correlation with a correlation coefficient of R = 0.90 between the cited patent documents and the year of under study.

Table 24: Number and origin of cited patents in the SCI through 1995-1999

Origin of Cited Patents	No. of Cited Patents	% of Cited patents
US	71,348	47%
EP	17,531	12%
JP	15,990	11%
DE	10,325	07%
WO	7,160	05%
RU	6,846	04%
GB	5,082	03%
FR	4,289	03%
Others	13,687	9%

Table 24 plots the total number, percentage, and the origin of cited patents in the SCI through 1995-1999. Table is restricted to the 8 top origin countries and organisations of cited patent documents.

A total number of 152,258 patents cited through 1995-1999 in the SCI. 71,348 (47%) of them were USPTO patents followed by EP with 12%, JP with 11%, DE with 7%, WO 5%, RU 4%, GB 3% and Fr 3% respectively. It is clear that the great number of cited patents through 1995-1999 were USPTO patents.

8.1 Result of section four:

In order to determine the difference among patent-citing documents and general scientific documents in the SCI, a total number of 142,617 documents from 1995-1999 were in the SCI chosen (a total number of 67,038 from these documents were patent-citing documents and 75,579 documents were randomly chosen). Patent citing documents found among randomly chosen documents were omitted. Analysis of patent citing and general scientific documents (randomized chosen) in the Science Citation Index through 1995-1999 showed that:

The number of cited references per paper for patent-citing documents ranged from 1 to 995, with a mean of 34.02 and mode of 15. The most heavily referenced and timely surveyed classic papers among patent-citing documents in the SCI were from the classic papers of the nineties (1836).

The number of cited references per paper for general scientific documents (randomly chosen documents) ranged from zero to 1,113 with a mean value of 28.76 and mode of 17. The most referenced citations among randomly chosen documents in the SCI were from the classic papers of 1939.

The half-life of citations to the patents was 41% higher than the half-life of citations to the general scientific documents (randomly chosen documents) in the SCI through 1994-1999. The half-life of citations to patents in the SCI was 8.1 years whereas the half-life of citations to the general scientific documents in the SCI was 5.73 years. This tendency seems to be due to the importance of patent documents, authors cite them in longer times than general scientific documents.

The number of citation classics used as cited references for the patent-citing documents was 8 times higher than the citation classics of general scientific documents. The mean value of proportion of citation classics for patent-citing documents and randomised chosen documents were 2% and 0.25% respectively through 1994-1999.

The mode of cited references per paper for patent-citing documents was lower (17 to 15) than in general scientific documents although the mean value of cited references for patent-citing documents was higher than others throughout the period of study. The mean value of cited references per paper for patent citing documents was 34.02 whereas the mean value of cited references for randomized documents was 28.76.

Almost half of all cited patents (47%) throughout the period of study were USPTO patents. In other words, a great number of scientists who cited patents have used the USPTO patents. The reason may be due to the technically and economically important of USPTO patents and the language bias; scientists prefer to use English more than other languages.

More than 90% of all patent-citing documents (the documents that referred to patents in their references) were in the form of articles.

Comparison of publications in the SCI and Web of Science related to GDP of countries in 1991 and 1999 among Canada, France, Japan, Germany and Italy indicated that Japan published the most expensive publications in 1991 as well as in 1999. Most probably the reason is that publications from Japan in the Science database were related to the high-tech. The great portions of Japanese publications were in Science rather than in Social Science and Art & Humanities Science. The portion of publications in Social Science and Art & Humanities Science from Japan was 13% and 17% respectively in 1991 and 1999.

9 Section five: The trend of IF and self-citation of journals:

Bearing this hypothesis in mind that there is an association between the journal self-citations, the Impact Factor, and their influence to the Matthew Effect, all references data was extracted from the annual volumes of the CD-Edition of the SCI and the web of science of the Institute for Scientific Information (ISI), the journal citation and self-citation data extracted from the JCR, the self-citing rate and self-cited rate calculated based on the JCR method.

To determine the growth of journals IF, all journal IF's indexed in the JCR throughout 1999-2005 were extracted and the mean value of their IF's calculated annually.

To show the difference of journals IF, all journals indexed in the JCR in 2002 were selected and the IF of the same set of journals in 2003 and 2004 extracted from the JCR, and the difference among them was calculated.

To determine the trend of self-citation of journals, a total number of 500 journals were randomly chosen in the JCR in 2005 and the same set of journals in the year 2000. If a journal was published in the year 2000 and it was cancelled in 20005 or it was published in 2005 but such journal was not found in 2000 (its publishing date was after 2000), an alternative journal which was published both in 2000 and 2005 was selected.

Table 25: Self-cited and self-citing ratios of some highly cited journals[130]

rank	journal	times cited	times citing	self citation	% self-cited	% self-citing	citing/cited	impact factor
1.	J. Am. Chem. SO..	26307	10135	3503	13.3	34.6	0.4	5.859
2.	Phys. Rev.	20666	14496	4452	21.5	30.7	0. 7	3.679
3.	J. BioL Chem.	17103	8659	2052	12.0	23.7	0 .5	6.371
4	Nature	15310	6777	888	5.8	13.1	0. 4	2.244

[130] Source: Garfield, E. (1974-76). Journal Citation Studies. XVII. Journal Self-Citation Rates – There's a Difference. Essays of an Information Scientist, Vol. 2, p.192-194.

5.	J. Chem. Sot.	13978	12230	2920	20.9	23.9	0 .9	3.123
6.	J. Chem. Phys	13687	10710	3599	26.3	33.6	0. 8	3.180
7.	Science	9739	5699	528	5.4	9.3	0 6	2.894
8.	Biochim. Biophys. Acts	9500	10269	1347	14.2	13.1	1 1	3.287
9.	P. Nat. Acad. Sci. USA	8206	4257	547	6.7	12.9	0 5	8.828
10.	Biochem. J.	7625	5220	848	11.1	16.3	0 7	3.193
11.	Lancet	7612	4409	884	11.6	20.1	0.6	1.509
12.	Phys. Rev. Letters	6544	3230	608	9.3	18.8	0.5	5.114
13.	Comptes Rendus etc.	5642	8398	1349	23.9	16.1	1.5	0.780
14.	Amer. J. PhysioL	5417	3783	598	11.0	15.8	0.7	3.379
15.	J. Org. Chem.	5394	6848	1045	19.4	15.3	1.3	2.407
16.	J. App[. Phys.	5274	5811	848	16.1	14.6	1.1	1.936
17.	P. Sot. Exp. Biol. Med.	5011	4901	371	7.4	7.6	1.0	1.964
18.	J. Mol. Biol.	4978	2486	620	12.5	24.9	0.5	9.302
19.	J. Physiology (London)	4960	2576	714	14.4	27.7	0.5	2.608
20.	P. Roy. Soc. London	4789	1746	103	2.2	5.9	0.4	3.484
average					**13.3**	**18.9**	**0.7**	**3.8**
501	Corrosion	276	259	43	15.6	16.6	0.9	1.473
502	IEEE T. Microwave Theory	273	697	138	50.6	19.8	2.6	1.242
503	Internat. J. Cancer	272	301	31	11.4	0.3	1.1	2.553
504	J. Nucl. Med.	268	309	44	16.4	14.2	1.2	0.505
505	Immunochemistry	265	417	26	9.8	6.3	1.6	3.639
506	IEEE T. Circ. Theory	265	381	91	34.3	23.9	1.4	1.344
507	J. Embryol. Exp. M&phoL	264	593	50	18.9	8.4	2.3	1.237

508	Mutation Res.	264	935	92	34.9	9.8	3.6	2.607
509	Rev. Neurologique	264	459	59	22.4	12.9	1.7	0.441
510	IEEE T. Inform. Theory	263	483	95	36.1	19.7	1.8	0.946
511	LimnoL Oceanogr.	263	320	54	20.5	16.9	1.2	1.285
512	T. Brit. Mycol. Sot.	263	549	73	27.8	13.3	2.1	0.830
513	Psychopharmacologic	260	435	37	14.2	8.5	1.7	2.409
514	J. Microscopic (Paris)	261	559	31	11.9	5.6	2.1	0.986
515	Strahlentherapie	259	970	132	51.0	13.6	3.8	0.464
516	Aerospace Med.	257	1030	101	39.3	9.8	4.0	0.551
517	Earth Planet. Sci. Lett.	257	892	63	24.5	7.1	3.5	2.262
518	P. Japanese Acad.	257	430	65	25.3	15.1	1.7	0.517
519	Amer. Psychologist	254	395	38	15.0	9.6	1.6	0.331
520	Amer. Zoologist	249	848	29	11.7	3.4	3.4	0.326
average					**24.6**	**11.7**	**2.2**	**1.3**

Based on table 25 Garfield found out in most cases, leading journals have a smaller self-cited than self-citing ratio. From the SCI core journals with the highest citations in 1969 we can see, that journal self-citing has, as an average, a ratio of 19% for the first 20 journals. This value is going down for journals ranked later on to 12%.

If this problem to be considered more precisely, it will show that there is a great variety of the self-citing ratios from zero to one (Figure 85), and that the comparison of two similar samples from 2000 “---“ and 2005 “ooo” shows similar distributions.

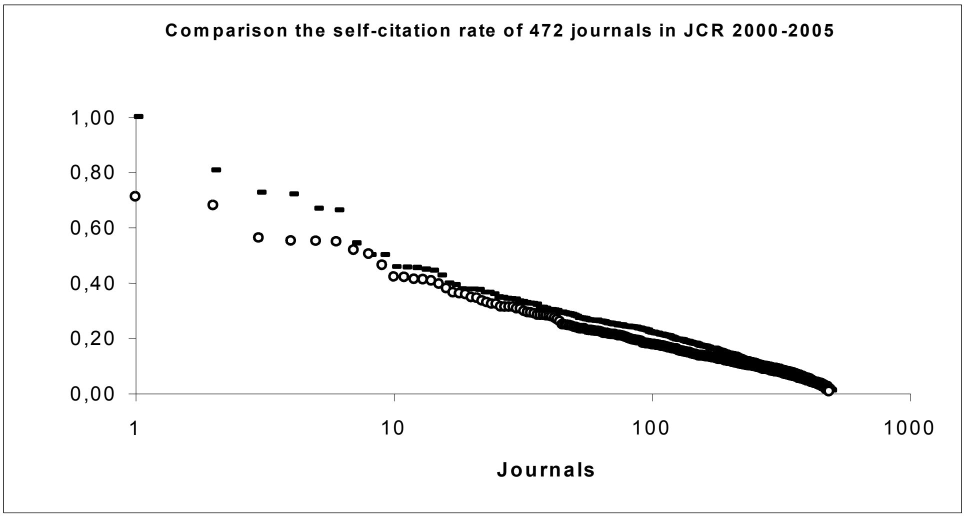


Figure 85: Comparison self-citation rate among 472 random chosen journals in the JCR 2000 and the same set of journals in 2005

The portion of journal self-citation in 2000 (o) is roughly 3% lower than in 2005 (-).

Since many years, in most cases a journal is first on the list of journals, ranked by Journal Citation Reports (JCR) that it cites most frequently.

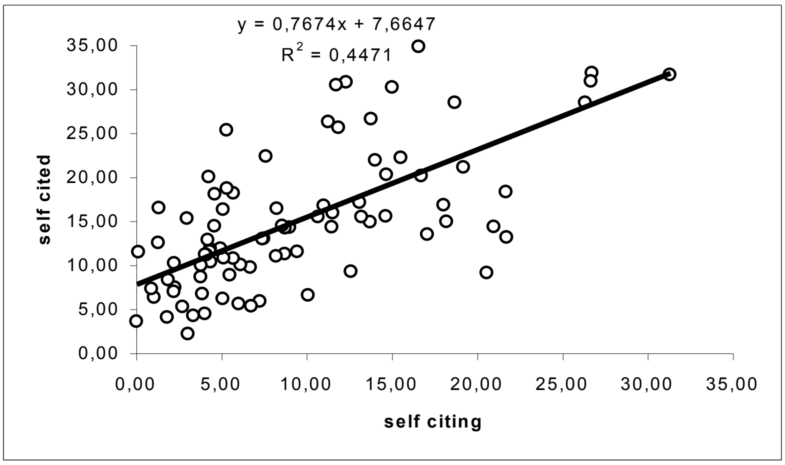


Figure 86: Journal self-citing and journal self-cited values for 87 journals from JCR[131]

[131] Tsay, Ming-yueh (2006). Journal self-citation study for semiconductor literature: Synchronous and diachronous approach Information Processing and Management 42, p.1567–1577.

The Figure shows the relation of journal self-citing to self-cited data from M. Tsay for a sample of 87 journals. It indicates, that the mean value of self-cited rate is 5.4% greater than the mean value of self-citing rate (The mean value of self-citing rate is 9.59% and the mean value of self-cited rate is 15.03%).

The correlation of citing and cited values is clearly a function of the number of papers per journal. As more papers are published in a journal as more reference it has and as more often it will be cited (Figure 86, 87 and 88).

Using the data from table 23, we see a rather clear correlation between the number of citations of one journal and the number that this journal is cited by other sources.

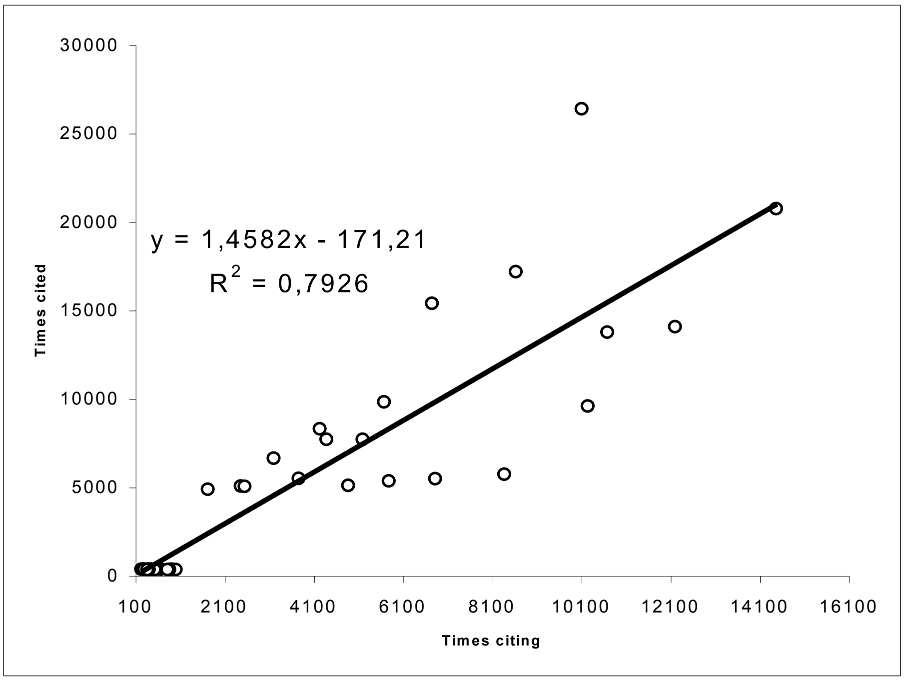
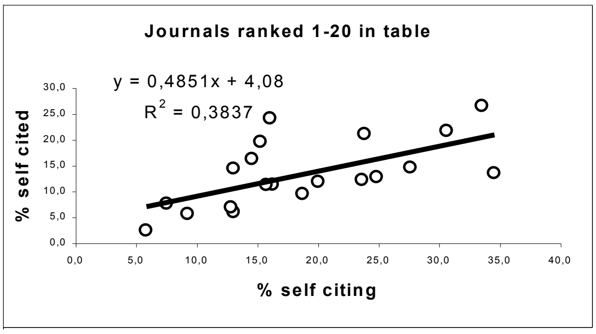
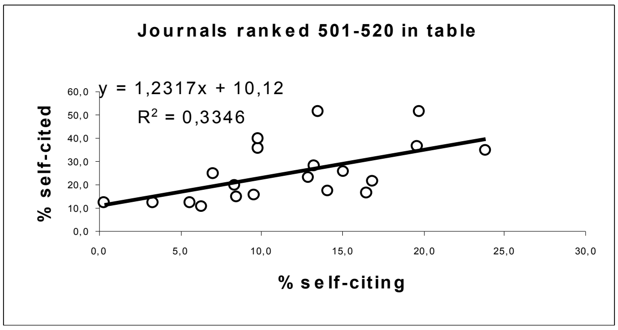


Figure 87: Comparison of the data from the columns “times cited” and “times citing” in table 23

As Figure 87 shows there is a linear correlation between the frequency of citing and cited times with a correlation coefficient of R = 0.89. The Figure indicates that as often a journal is citing other journals as more often it is also cited by a factor of 1.5 from others. In other words every 2 citations by a journal cause that the journal to be cited 3 times. In consequence the growing percentage of journal self-citation is followed by journal self-citedness.





a b

Figure 88: Comparison of the journal self-citation data from the columns "% self-cited" and "% self-citing" in table 25

The linear regression functions in the Figures 86-88 show that the value from Tsay (0.767) is in the middle of Garfield's values (0.485 an 1,232).

$y = 0.7674x + 7.66$ $R^2 = 0.45$ (from M. Tsay, 2001)

$y = 0.4851x + 4.08$ $R^2 = 0.38$ (from E. Garfield 20 first ranked journals)

$y = 1.2317x + 10.12$ $R^2 = 0.38$ (from E. Garfield journals ranked 501-520)

Comparison of the journal self-citation data from the columns "% self-cited" and "% self-citing" in table 23 makes clear that journals with high citation rates (Figure 88a) have a lower self-citedness and (Figure 88b) vice versa. The results from Tsay have to be seen as an average.

The distribution of self-citation follows roughly a log-normal distribution, so that we have to distinguish between the mean value of roughly 15% journal self-citing and the mode of roughly 10%. That means also, that the journals in the SCI got some more citations per paper and also higher IFs by journal self-citation.

If we assume, that only 12% of the references are journal self-citations, and if we compare these values with the increase of two thousand IFs in the years 2002 to 2004, then we see a clear parallel development. With other words, the raising IF in the SCI is produced by the growing number of references per paper and the nearly constant journal self-citation rate.

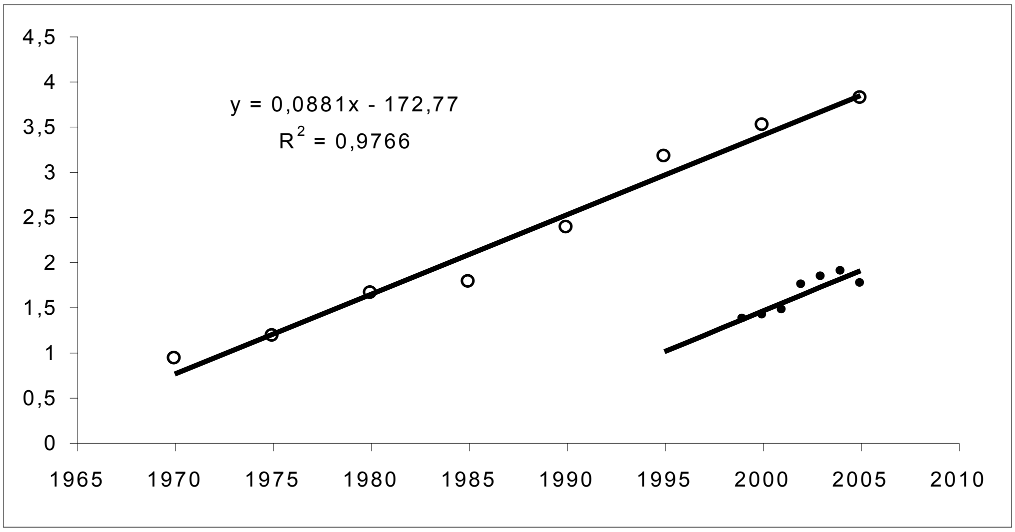


Figure 89: The parallel increase of IF (black points) by the raise of references per paper and the increase of citations to the same journal

Figure shows, the parallel increase of IF (black points) by the raise of references per paper and the increase of citations to the same journal.

The great differences in journal self-citation rates from zero to one have different causes.

One can be identified in the specialization of the journals e.g. pomology, urban entomology or leather chemistry are without any doubt very special topics. This is a hint, that some of the journals with very special topics are much more concentrated to few journals than more interdisciplinary topics. Such differences are well known since the classical observations of Bradford in 1948.

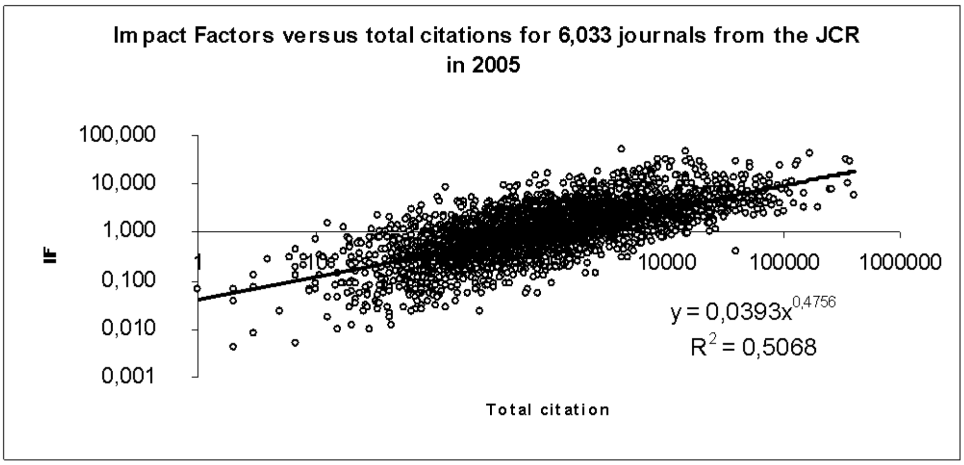


Figure 90: Impact Factors versus total citations for 6,033 journals from the JCR in 2005

As Figure 90 illustrates, there is a power law correlation with a correlation coefficient of R = 0.71 between the Impact Factors and the total citations of journals. The majority of journals with citations greater than 1,000 belong to the journals with IF >1. There is a strong correlation between total citation and Impact Factors. 38.28% of total citation belong to the 5.8% of Journals with Impact Factor higher than 4. And 61.72% of total citation belongs to the 94.20% of journals with IF lower than 4. There is also an important hidden correlation between the IF and self-citation of journals.

With consideration the correlation between "times cited" and "times citing" of journals by a factor of 1.5 (as illustrated in Figure 88), the role and the influence of self-citation among journals to the increase of IF would be clear.

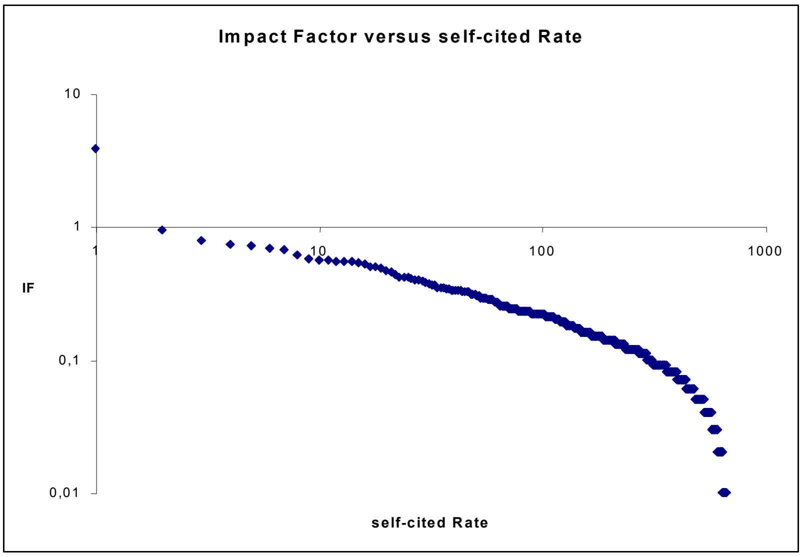


Figure 91: Impact Factor versus self-cited rate

As Figure 91 shows the self-citation rate has a negative correlation with IF. With lower IFs the self-citation rate is higher. In other words the journals with lower IF tend to be cited more by themselves. Most probable they have very special topics.

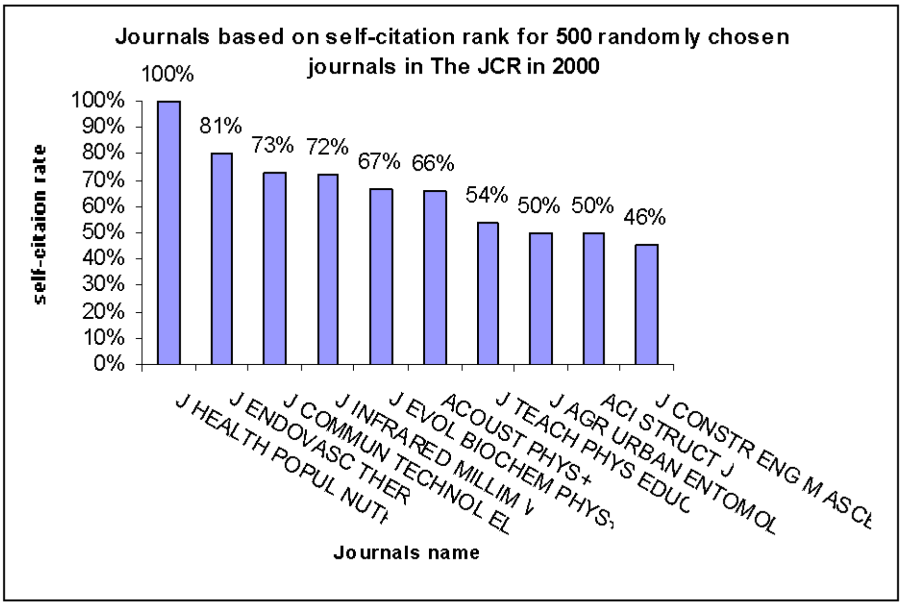


Figure 92: Distribution of journals based on self-citing rank for 500 randomly chosen journals from the JCR in 2000

The journals are ranked according to the adjusted self-citation rank. As Figure illustrates, "*JOURNAL OF HEALTH POPULATION AND NUTRITION*" with 100% self-citation rate is the top self-citation journal followed by "*JOURNAL OF ENDOVASCULAR THERAPY"* with 81% self-citation rate and "*JOURNAL OF COMMUNICATIONS TECHNOLOGY AND ELECTRONICS*" with 73% self-citation rate. The Figure is restricted to the 10 top self-citation journals.

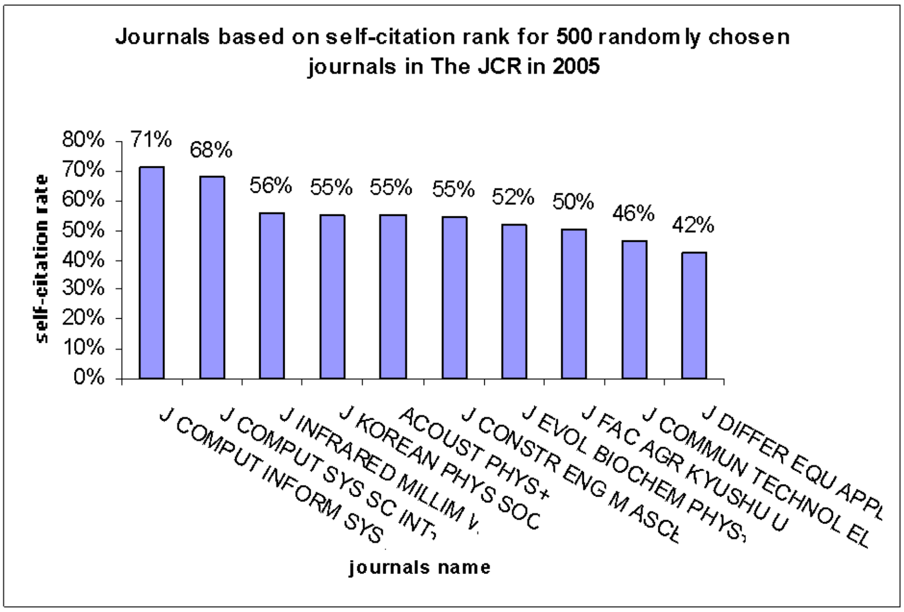


Figure 93: Distribution of journals based on self-citing rank for 500 randomly chosen journals from the JCR in 2005

As Figure illustrates *“JOURNAL OF COMPUTER INFORMATION YSTEMS”* with 71% self-citation rate is the top self-citation journal followed by *“JOURNAL OF COMPUTER AND SYSTEMS SCIENCES INTERNATIONAL”* with 68%, *“JOURNAL OF INFRARED AND MILLIMETER WAVES”* with 56%, *“JOURNAL OF THE KOREAN PHYSICAL SOCIETY”* with 55%, *“ACOUSTICAL PHYSICS”* with 55%, *“JOURNAL OF CONSTRUCTION ENGINEERING AND MANAGEMENT-ASCE”* with 55%, *“JOURNAL OF EVOLUTIONARY BIOCHEMISTRY AND PHYSIOLOGY”* with 52%, *“JOURNAL OF THE FACULTY OF AGRICULTURE KYUSHU UNIVERSITY”* with 50%, *“JOURNAL OF COMMUNICATIONS TECHNOLOGY AND ELECTRONICS“* with 46% and *“JOURNAL OF DIFFERENCE EQUATIONS AND APPLICATIONS”* with 42% self-citation rate respectively in 2005.

The Figure is restricted to the 10 top self-citation journals.

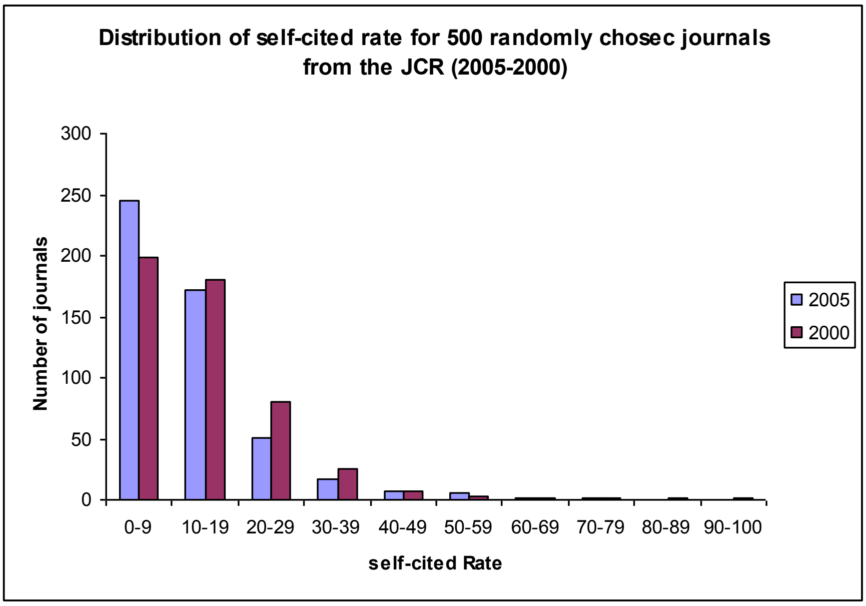


Figure 94: Distribution of self-cited rate for 500 randomly chosen journals from JCR 2000-2005

As Figure 94 indicates, 422 journals (84.4%) from a total of 500 randomly chosen journals in the JCR in 2005, had self-citations rates at or below 20 percent. The population shows a mean value of self-citation rate equal to 12 with a median of 10 in 2005. This result is consistent with the finding of Marie E. McVeig[132] who found 82% of all journals in the JCR in 2002 had self-citation rates at or below 20 percent with a mean self-citation rate equal to 12.41 and median of 9.04.

The mean value of self-citation rate is equal to 14.81 with a median 12 for 500 randomly chosen journals in 2000.

As the Figure illustrates, the largest group in the self-cited group is that with the least self-cited rate less than 10% which account for 245 journals (49%) from a total of 500 randomly chosen journals in 2005 and 198 journals (39.6%) in 2000.

The second large group is the journals with a cited-rat from 10% to 20% in 2005 as well as in 2000 which constitute 34.4% of all journals in 2005 and 36% in 2000.

From a total of all 500 randomly chosen journals, 97.4% of all population in 2000, and 97.2% in 2005 had at least one citation to their own.

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[132] McVeigh, Marie E. (2002). Journal self-citation in the Journal Citation Reports – Science Edition (2002). Retrieved November 14, 2006 from http://scientific.thomson.com/free/essays/journalcitationreports/selfcitation2002/

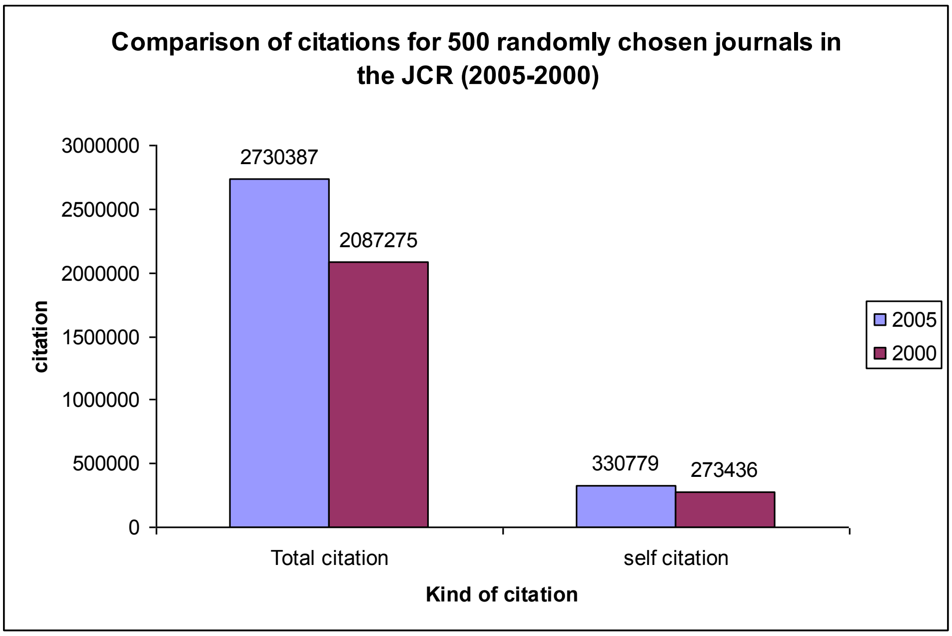

Figure 95: Comparison of citation and self-citation in 500 randomly chosen journals in the JCR (2005-2000)

Figure 95 illustrates the growth of citations and self-citation in 500 randomly chosen Journals in the JCR in the years 2000 as well as in 2005 in the same set of journals.

Although the portion of self-citation over the span of the years stays approximately between 10-15% constant, but with considering that the number of total citation increased steady over the time, then the constant portion of self-citation has increased parallel with the total citation. For example total citation for 500 randomly chosen journals in the JCR in 2000 is 2,087,275 citations and the portion of self-citation is 273,436 (13.10% of total citations in this year). The total citation in 2005 for the same set of journals is 2,730,387 citations, and the portion of self-citation in this year is 330,779 (12.11% of all total citation).

It is clear that the 12.11% self-citation ratio in the year 2005 is 57,343 citations more that the 13.10% of self-citation ratio in the year 2000.

Table 26: Mean value of journals self-citation rate for 3 groups of journals in the JCR 2005

IF	No. of selected journals	Percent of selected journals in the JCR	Mean value of self-citation rate	No. of total-citations	No. of self-citations	Mean value of total-citation per journal	Mean value of self-citation per journal
IF > 9.846	100	1.64%	2%	3,255,988	75,497	32,559.88	754.97
4.352< IF > 5	100	1.64%	6%	1,085,570	101,486	10855.70	1014.86
IF < 0.052	100	1.64%	17%	10,613	1,999	106.13	19.99

All 6,088 journals indexed in the JCR in 2005 were sorted ascent based on the IF. A total number of 100 journals with highest IF (IF>9.847), 100 journals with middle IF (4.352< IF > 5), and 100 journals with lowest IF (IF<0.052) were chosen in order to compare the total-citation and self-citation behaviour among journals in the JCR.

As table 26 indicates, the mean value of self-citation rate among journals with highest IF is 2% and this rate among the journals with lowest IF is 17%, in other words the self-citation rate among the journals with lowest IFs in the JCR is more than 8 times greater than the self-citation rate of journals with highest IFs.

Although the self-citation rate among the journals with highest IFs is 8.5 times lower than the self-citation rate among the journals with lowest IFs, but it is considerable that the mean value of total citation per journal among journals with highest IFs is 307 time higher than the mean value of total-citation per journal among the journal with lowest IFs. And the mean value of self-citation per journals among the first group (the journals with highest IFs) is 38 times higher than the later group (the journals with lowest IFs). As a mean value we see about 755 self-citations per journal with highest IF. With consideration to the correlation between "times cited" and "times citing" of journals (Figure 87) that every two self-citation caused the journal to receive three citations, then every high IF journal in the JCR has received about 1,132 citations because of their self-citation in 2005.

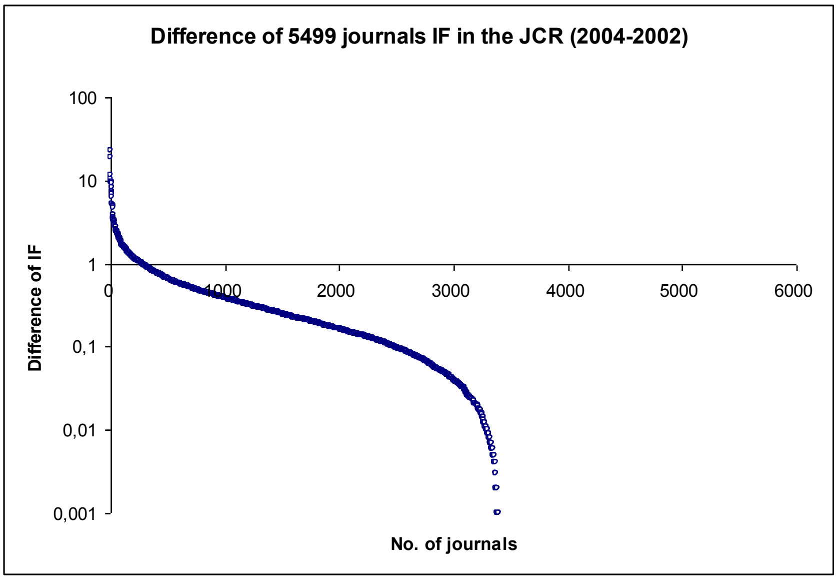

Figure 96: Difference of Journals Impact Factor for 5,499 journals in the JCR in 2004 and the same set of journals in 2002

As Figure 96 indicates, 61.81% of all journals IF in 2004 indexed in the JCR with compare to the same set of journals in 2002 has increased, 0.42% stayed unchanged, and 37.77% has sunk. It means that the number of citations to the journals increased over the years.

9.1 Result of section five:

Analysis of data showed that the number of references per paper in the SCI from 1970 to 2005 has steadily increased. It reached from 8.40 in 1970 to 34.63 in 2005, an increase of higher than 4 times.

Comparison of journals Impact Factor for 5,499 journals in the JCR in 2002 and the same set of journals in 2004 showed that 75% of journals IF have increased over the span of the years in the same set of journals. It means that the number of citation per journals has increased over the span of years.

There was a significant correlation between the IF and total citation of journals in the JCR, and there was an important hidden correlation between IF and the self-citation of journals. The IF of journals has increased parallel by the raise of references per paper and the increase of citations to the same journals throughout 1999-2005. The result of study is in contrast to the consideration of Marie E. McVeigh[133] who observed that the self-citation rate has a weak correlation with the Impact factor of a journal. Although the proportion of self-citation stayed nearly constant, but it is considerable that the number self-citation increased parallel with the number of total citations and this phenomena has caused to increase the total number of citations which led to the increase of journals' IF in the SCI.

On the other hand the result of study validated the consideration of Fassoulaki A, et al which they found a significant correlation between self-citing rates and impact factors ($r = 0.899$, $P = 0.015$) among six the six anaesthesia journals through 1995 -1996.

The study showed that there was a linear correlation between journal self-citing and journal self-cited value, the mean value of self-cited rate always stays higher than the self-citing rate.

The mean value of self-cited rate in 2000 was 14% and the mean value of self-citing rate was 6.61%, whereas the mean value of self-cited rate in 2005 was 12% and the mean value of self-citing rate was 7.81%.

As often a journal citied other journals, it was cited itself by a factor of 1.5 by others. In consequence the growing percentage of journal self citation was followed by journal self-citation.

[133] McVeig, Marie E. (2002). Journal self-citation in the Journal Citation Reports-Science Edition (2002). Retrieved November 14, 2006 from http://www.elyadal.org/seminerler/ssci/docs/selfcitations.pdf.

10 Discussion:

10.1 Patent applications

It is a generally accepted idea that patents are important indicators of national innovations.

“Patent counts can be useful measures of innovative output“.[134]”A country’s patenting activity can be measured in relation to its gross domestic product (GDP) to provide an indicator of productivity”[135]

The study of Dereck De Solla Price generated the study of Narin F. not only for analysing scientific publication but also for analysing of patenting activities versus the economic size. Figure 97 shows the number of granted patents in the United State Patent System to inventors from different countries versus the GDP of countries from the study of Narin F.

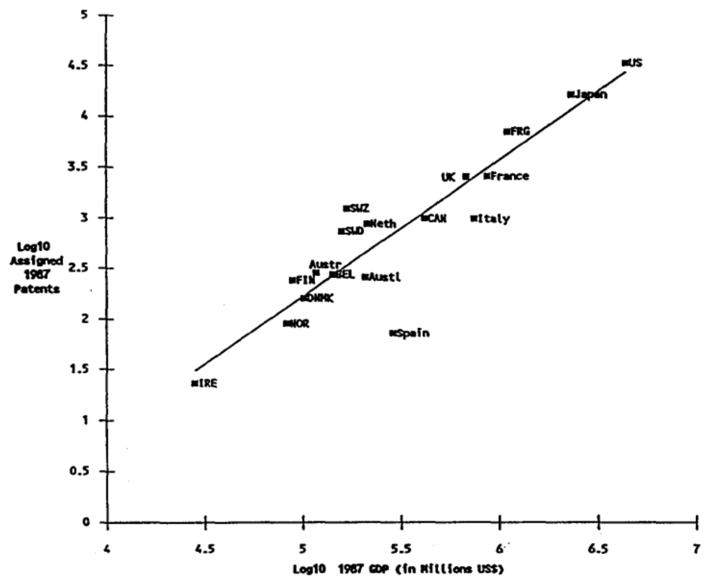

Figure 97: Number of assigned U.S. Patents versus GDP of 18 countries in 1967 from the study of Narin F.

As Figure 97 shows, Nairn F. found a correlation between the number of patents assigned to the USA patent system and GDP of 18 countries in 1967.

[134] Hall, Brown H. (2004). Patent data as Indicators. Retrieved May 27, 2007 from http://www.oecd.org/dataoecd/45/23/33835392.pdf

[135] Australian Research Council Annual Report 2000. Retrieved May 27, 2007 from http://www.arc.gov.au/pdf/00_05.pdf

Although Nairn F. found out that there is a relationship between the patent output as the indicators of science and technology and GDP of countries, but he did not go in more details and did not specify this relationship.

The study of Greif, S. (1998) showed that there is a positive correlation between the R&D expenditure of countries and the number of patent applications in the countries. “Je höher die F+E-Ausgaben sind, umso größer ist die zahl der Patentanmeldungen.“[136]

Although Greif, S. studied the number of patent activity versus R&D expenditure of countries and not exactly patents versus GDP of countries. We are aware that there are some controversial arguments about assessing the exact amount of R&D expenditure in the countries. Nevertheless this is an indication for relationship of wealth in a country and innovation activities.

The Australian Research Council and the Common wealth Scientific and Industrial Research Organisation[137] (2000) in its official report in Jun 2000 revealed the relationship between the innovation activities (patenting activities) and the GDP of countries in the fiscal year 1998. The organization showed the counts of granted patents versus GDP of 22 countries. They calculated the average patent activity for 22 countries and emphasised that Australia’s patenting performance is considerably below the average, and it would need to increase its patenting activity by 70 percent, or almost 550 patents per year. There was a correlation between patent activity and GDP of 22 countries with a correlation coefficient of R = 0.91. They derived the result that a country’s patenting activity can be measured in Relation to its gross domestic product (GDP) to provide an indicator of productivity.

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[136]Greif, Siegfried (1998). Strukturen und Entwicklungen im Patentgeschehen.In:Wissenschaftsforschung: Jahrbuch 1996/97. Hrsg. v. Siegfried Greif, Hubert Laitko u. Heinrich Parthey. Marburg: BdWi-Verlag 1998. p. 97 - 136.

[137] The Australian Research Council and the Common wealth Scientific and Industrial Research Organisation. Innovating our Future (1999). Retrieved May 25, 2007 from http://www.arc.gov.au/pdf/00_02b.pdf

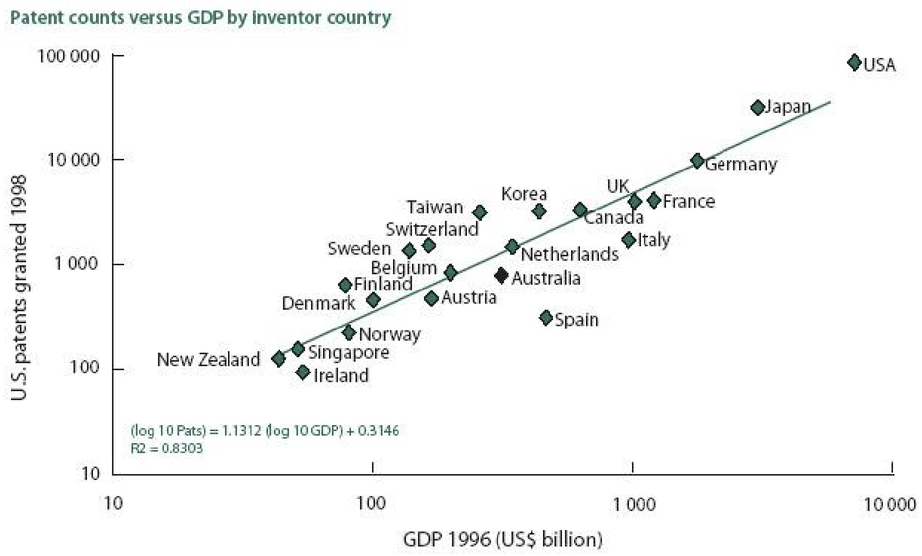

Figure 98: Correlation between the patenting activities versus the GDP of 22 countries in 1998 from the annual report of Australian Research Council in 2000.

Figure 98 shows that, there is a linear correlation between the patent applications and the GDP of countries with a correlation coefficient of R = 0.9 (R^2 = 0.8303).

Another study commissioned by the Australian Research Council and the CSIRO[138] showed that there is a relationship between the number of patents and GDP of countries with a correlation coefficient of R = 0.82 (R^2 = 0.68) in the fiscal 2000 (Figure 99).

[138] Australian Research Council (2000). 'Inventing Our Future – the link between Australian Patenting and basic science, p 39-40

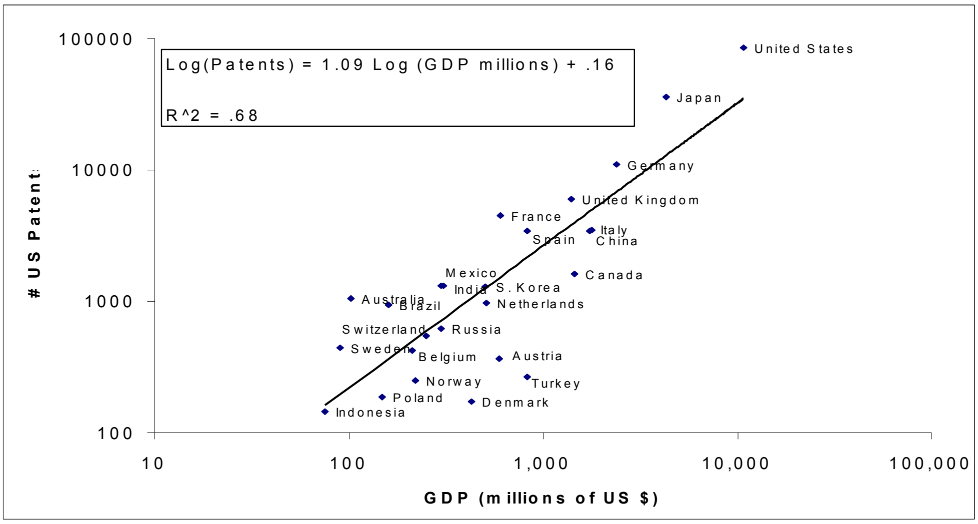

Figure 99: patent counts versus GDP of countries in 2000 from the report of Australian Research Council and the CSIRO

As Figure 99 shows the Australian Research Council and the Common Wealth Scientific and Industrial Research Organisation found a linear relationship between the number of patents and GDP of countries with a correlation coefficient of R = 0.82 in 2000.

Fan S.[139] (2005) researched the quantitative relationship between patent quantity and Gross Domestic Product of certain countries with high patent output through 1998-2003. He found that there is a strong power function between developed countries' patent output and GDP with a correlation coefficient of R = 0.9 (R^2 = 0.817).

Heinz M.[140]surveyed the ratio of publications in the SCI for 50 more productive countries versus GDP in 2002. In determining the proportion of a country at SCI he used a fractional of counting. If several countries in an article involved, so several countries addresses appeared in the article. They got only a portion of the article into account. "Bei der Bestimmung des Anteils eines Landes am SCI benutzen wir eine fraktionale Zählweise. Wenn mehrere Länder an einem Artikel beteiligt sind, also mehrere Länder in den Adressen eines Artikels vorkommen, so bekommen sie auch jeweils nur einen Teil des Artikels angerechnet". He

[139] Fang ,Shu (2005). Power-law Fractl: The law of Technological Innovation output Statistics. Proceedings of ISSI 2005, Vol. 1, p.121-128.

[140] [140] Heinz, Michael (2006). Bemerkungen zur Entwicklung der Internationalität der Forschung – Bibliometrische Untersuchungen am SCI. Retrieved January 12, 2007 from http://edoc.hu-berlin.de/miscellanies/vom-27533/131/PDF/131.pdf.

found out a linear correlation between the number of publications in the SCI and the GDP of 50 more productive countries with a correlation coefficient of R = 0.99 (Figure 100).

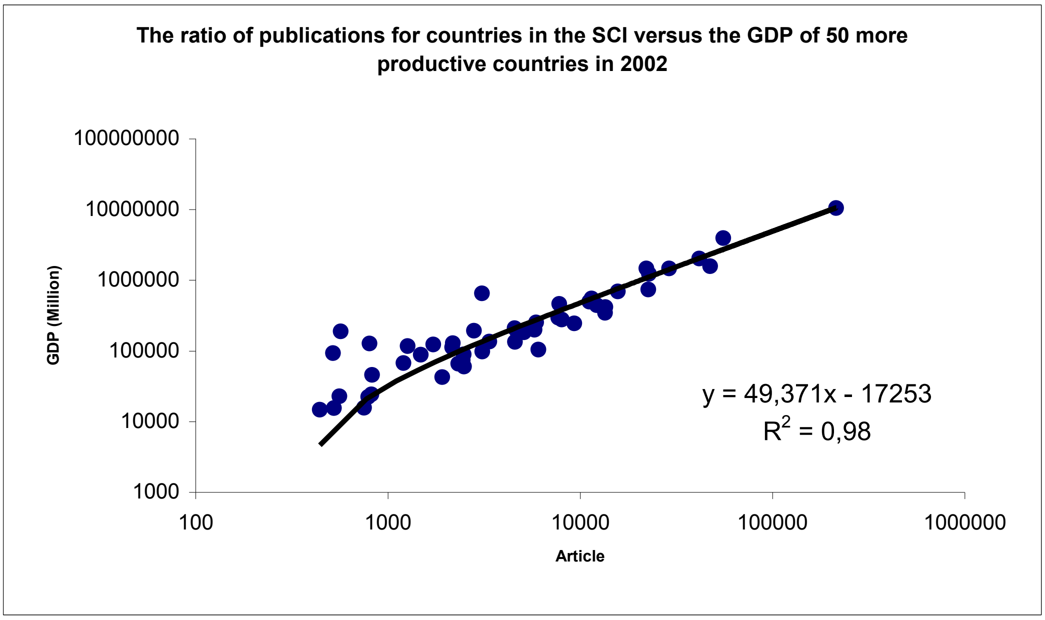

Figure 100: The ratio of publications for 50 more productive countries versus GDP in 2002 from the study of Heinz M.

It is remarkable that in the Figure above the countries with fewer publications stay far away from the regression line.

The WIPO (2006) in its "Statistics on Worldwide Patent Activities" (2006) denoted that the annual Growth of patenting in WIPO was beside the growth of GDP. "The number of patent applications filed worldwide almost doubled between 1985 and 2004, rising from 884,400 to 1,599,000 with an average annual rate of increase of 4.75% since 1995. This is in line with the average annual growth in world gross domestic product (GDP) of some 5.6%."[141] In other words the report indicated that there was a relationship between the amount of GDP and the number of patent applications in the countries.

[141] Wipo Patent Report. Retrieved May 25, 2007 from http://www.wipo.int/ipstats/en/statistics/patents/pdf/patent_report_2006.pdf

In another study Ye Fred Y.[142] (2007) assessed the quantitative relationship between per capita GDP and Scientomertic criteria of 24 countries. His study was based on IMF (International Monetary Found), WIPO and UNESCO statistical data. He found that there is a quantitative relationship between per capita GDP and some scientometric criteria such as gross expenditure<e on R&D as percent of GDP, patent applications, and Internet user per 10,000 inhabitants, which he expressed as "$G = kF(lgP)N$, where G is per capita GDP, F gross expenditure on R&D as percent of GDP, P patent applications, N Internet users per 10,000 inhabitants, and k a constant ranging from 0.4 to 1.2 in most countries. If $k>1$, it shows that GERD% (Gross Expenditure on the R&D as percent of GDP) is weaker and fewer than in normal cases. When $k>1.6$, there are few patents, so that innovative activities seem very weak in the country. If $k < 0.4$, it shows that there are many more patent applications than grants of patents, so that creative quality seems bad in the country"[143]

Analysis of patent applications in the study showed that USA was the leading country filing patents as well as granting patents, followed by Japan, Germany, U.K., France and Canada. The results of this study validated the study of Yen-Chun Jim Wu[144] who found that the USA, Japan and Germany were the three top patenting countries through 1991-2001. Likewise validated the study of Kanama D.[145]who found that the USA, Japan and Germany were the three top patenting countries in the field of nanotechnology submitted to the four largest patent organizations (JPO, USPTO, EPO, and WIPO) through 2003-2005. It is also in agreement with the study of Greif. S[146]. who found that the USA, Japan and Germany were the three top countries in 1990 applying for patents.

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[142] Ye, Fred Y. (2007). A quantitative relationship between per capita GDP and scientometric criteria. Scientometrics, Vol. 71, No. 3, p. 407-413.

[143] Ibid

[144] Wu, Yen-Chun Jim (2005). Unlocking the value of business model patents in e-commerce. The Journal of Enterprise Information Management, Vol. 18, No.1, p. 113-130. Retrieved May 24, 2007 from http://www.emeraldinsight.com/Insight/ViewContentServlet;jsessionid=8B0853DE361189102F583740F3F16BD2?Filename=Published/EmeraldFullTextArticle/Articles/0880180107.html#0880180107003.png

[145] Daisuk, Kanama (2006). Patent application Trends in the Field of Nanotechnolog. Retrieved May 24, 2007 from http://www.nistep.go.jp/achiev/ftx/eng/stfc/stt021e/qr21pdf/STTqr2105.pdf

[146] Greif, Siegfried (1998). Strukturen und Entwicklungen im Patentgeschehen.In:Wissenschaftsforschung: Jahrbuch 1996/97. Hrsg. v. Siegfried Greif, Hubert Laitko u. Heinrich Parthey. Marburg: BdWi-Verlag 1998. p. 97 - 136.

Analysis of data further showed that, there is a strong correlation between GDP and patent applications in the USPTO, WIPO, and EPO.

The relationship between the GDP in countries and patent applications in the USPTO, WIPO, and EPO is a linear relationship. Although mathematical analysis approved this relationship and some software packages such as SPSS and excel validated it, we found out that the countries with lower patent applications in linear correlations are beneath the regression line. An accurate look to the Figures 101 and 102 illustrates the discrepancy. The cause for this bias is very simple. Low values have much smaller square values than GDP values in the range of 10^{12} \$. So far it is logical to choose the better fitting power law, which the other researchers apparently missed. It is clear that the regression coefficient in linear correlation is mathematical higher than the power law correlation. Most probably this was the reason that former researchers chose the linear regression.

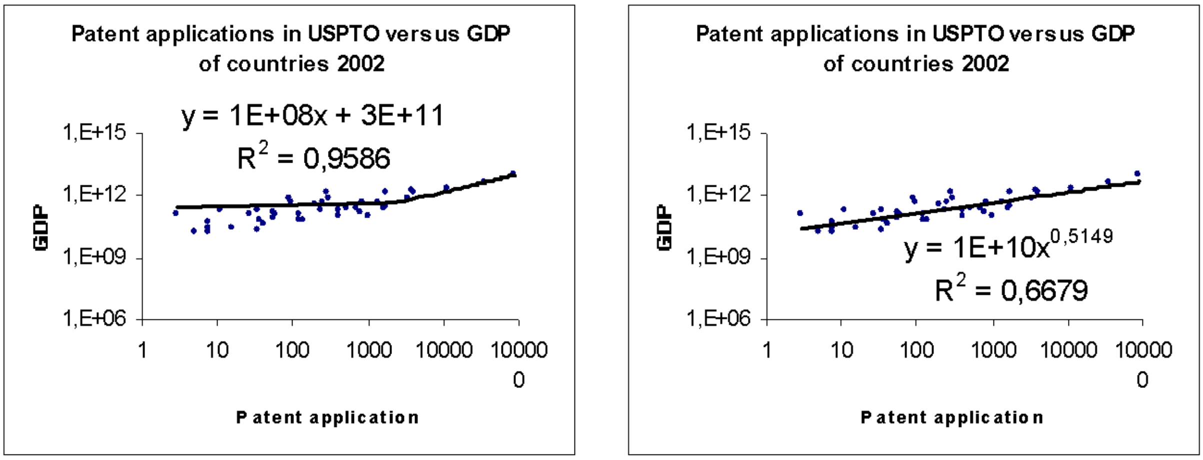
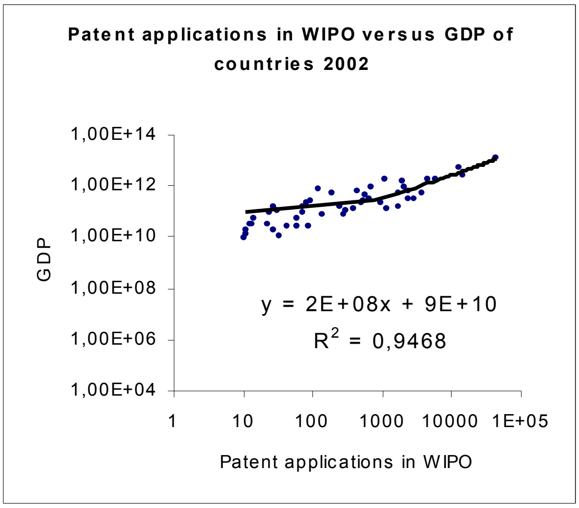


Figure 101: Relationship between patent applications in USPTO and GDP of countries in 2002(R = Linear correlation and L = Power law correlation)



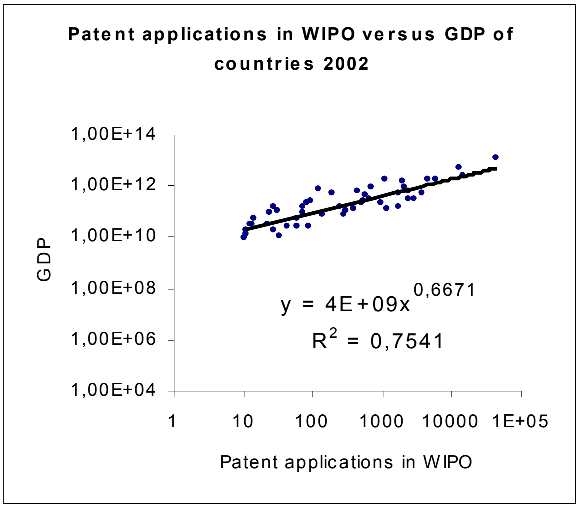


Figure 102: Relationship between patent applications in WIPO and GDP of countries in 2002(R = Linear correlation and L = Power law correlation)

The relationship between patent application and GDP for the countries with applications greater than 500 patents annually is a linear relationship with a correlation coefficient of R > 0.96 (Figure 103). This is the most interesting result among the results of the studies, those involved with the patenting activities so far, because none of them specified such relationship between the GDP and patent applications of countries. Most probably the positive effects of innovation activities percolate through the economy of countries and the increase income raises the potential for new investments. This relationship is a very valuable exploration. It makes possible to predict and expect one country’s patent application quantity or innovation activity through analysing its GDP and vice versa.

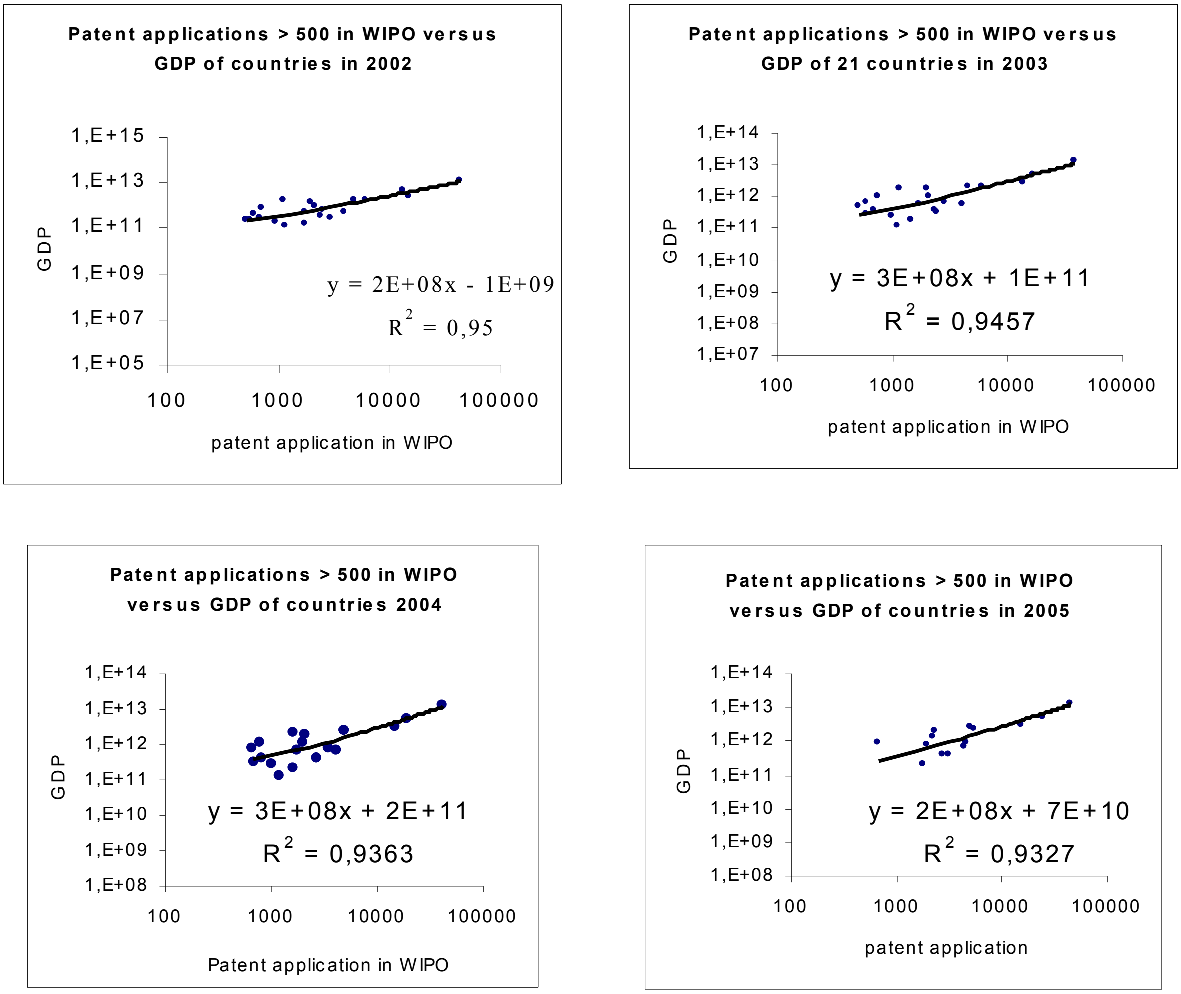


Figure 103: Patent applications > 500 in WIPO through 2002-2005

Figure 103 shows the relationship between patent applications and the GDP of countries, whose patent applications were greater than 500 applications annual throughout 2002-2005 in WIPO. Figures indicate that there is a strong linear relationship between GDP and patent applications > 500 with a correlation coefficient of $R > 0.96$.

Although the relationship between patent applications and GDP of countries was recognized by other researchers too, but this is the first attempt to investigate the relationship between patent applications and GDP of countries in considerable depth, by examining the idea, that there is a linear correlation ($R > 0.96$) between the GDP and patent applications of countries, whose applications are greater than 500 patents annually.

The study showed that the number of patent applications in USPTO has power law correlation with the portion of publications for countries in the SCI.

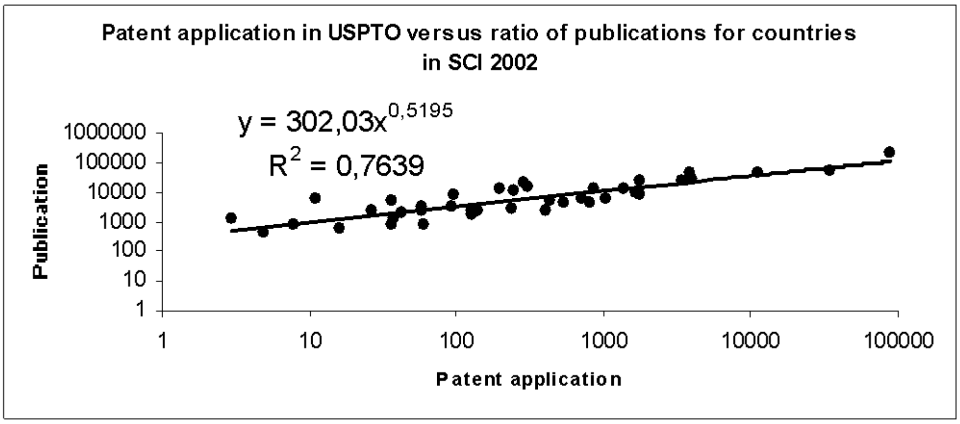


Figure 104: Patent applications in USPTO versus the portion of publications for 50 more productive countries in the SCI in 2002

Figure illustrates the relationship between the numbers of patent applications in the USPTO versus the numbers of articles in the SCI in the fiscal year 2002. The proportion of publications for countries in the SCI was extracted from the study of Heinz M. The Figure indicates that there is a power law correlation between the patenting activities in the countries and the portion of scientific publications in the SCI.

We found out that there is a weak correlation between the amount of patent applications and the size of population in the countries (Figure 21). This is in agreement with the findings of Dereck De Solla Price. The reason is most probably that the money for science is more important than the number of people in not sufficient educated countries.

10.2 Publications in the Science databases versus GDP of Canada France, Japan, Germany and Italy

The organisation for economic co-operation and development (OECD) analysed the scientific output relative to government on R&D expenditure as a measure of cost-effectiveness. "We looked at the ratio of citations per pound spent in terms of government total funding of R&D and also in terms of government civil spending on R&D."[147]The study revealed that Canada and UK which published 13.3 and 9.6 papers per million pound in relation to R&D expenditure that were respectively the most "cost-effective" publishing countries among the

[147] The evaluation of scientific research: selected experiences (1997). Organization for Economic Co-operation and Development. Retrieved October 12, 2007 from http://www.oecd.org/dataoecd/9/26/2754549.pdf

G7 countries in 1991. Japan followed with 6,6 papers per million pounds, United States with 5, Germany with 4.7, Italy with 3.5 and France with 3.4.

We investigated the number of publications in the SCI (Web of Science) versus GDP of countries rather than the R&D expenditure. The reason is that data about R&D expenditures deviates highly in different sources. At first because there are different kinds of R&D expenditures (money from foundations, the government, the industry, military institutions, the universities, etc.) and at second because the different types of scholarship, that makes the definition of R&D expenditures ambiguous. The failure in calculations of R&D expenditure in the countries is at least two times higher than the GDP. To prove this discrepancy we looked for the R&D expenditure of USA for 2003 from 6 different sources. The values are:

114,000,000,000 US$[148]	=	100%
176,415,000,000 US$[149]		155%
272,200,000,000 US$[150]		239%
285,000,000,000 US$[151]		250%
291,864,000,000 US$[152]		256%
311,817,000,000 US$[153]		274%

It is reasonable to assess the number of publications for countries versus GDP rather than the R&D expenditure. There is an official database for extracting the GDP of countries (World

[148] OECD Science, Technology and Industry Scoreboard 2005, Retrieved October 11, 2007 from http://www,oecd,org/dataoecd/17/43/35471661,pdf

[149] Canadian National Statistic Aagency Industrial research and development – 2005 intentions Catalogue No, 88-202-XIE. Retrieved October 12, 2007 from http://www,statcan,ca/english/freepub/88-202-XIE/88-202-XIE2005000,pdf

[150] Gannon, Frank (2003), Government rhetoric and their R&D expenditure. Reports, Vol.4, No.2, p. 117–120. Retrieved October 12, 2007 from http://www,nature,com/embor/journal/v4/n2/full/embor746,html

[151] OECD SCIENCE, TECHNOLOGY AND INDUSTRY SCOREBOARD 2005. Retrieved October 13,2007 from http://www,oecd,org/dataoecd/17/44/35471670,pdf

[152] National Science Foundation. Retrieved October, 12, 2007 from http://www,nsf,gov/statistics/infbrief/nsf06306/

[153] Lee, Johnsee (2006), Technology R&D: A Strategic Approach to Technology R&D: A Strategic Approach to Economic Development in Taiwan Economic, Retrieved October 11, 2007 from http://www,aba,org,tw/doc/23rdGM%20Speeches/Johnsee%20Lee%20printversion,pdf

Economic Outlook Database). This makes the study more reliable. Looking for the GDP of USA, the deviation was in comparison very small.

GDP USA 2003 in US$:

10,400,000,000,000 (2002)[154]		
10,400,000,000,000[155]	=	100%
10,881,609,000,000[156]		105%
10,971.250, 000,000[157]		105%
10,987,900,000,000[158]		106%

Another controversial argument for using the R&D as a valid indicator, "that for every successful project, ten projects fail. In addition, businesses investing in the R&D must take into account the likelihood of imitation by competitors, and also the uncertainty in the timing of commercialization of the R&D project, especially for basic and applied research. Because of the wide range of estimated rates of return, the assumption made is that the average private rate of return is 25 percent and the average social rate of return, which includes spillovers, is 50 percent."[159]

Comparison of publications in the SCI and Web of Science related to GDP of countries in 1991 and 1999 among Canada, France, Japan, Germany and Italy indicated that Japan published the most expensive publications in 1991 as well as in 1999. Most probably the reason is that publications from Japan in the Science database were related to the high-tech. The great portions of Japanese publications were in Science rather than in Social Science and Art & Humanities Science. The portion of publications in Social Science and Art & Humanities Science from Japan was 13% and 17% respectively in 1991 and 1999. Contrary to

[154]Retrieved October 12, 2007 from http://www.bartleby.com/151/fields/62.html

[155] Retrieved October 12, 2007 from http://www.theodora.com/wfb2003/rankings/gdp_2003_0.html

[156] Retrieved October 12, 2007 from http://www.spx.org/teachers/socialstudies/pcook/documents/2003GDPfromWorldBank.pdf

[157]World Economic Outlook Database. Retrieved October 12, 2007 from http://www.imf.org/external/pubs/ft/weo/2006/01/data/index.htm

[158] Infoplease database. Retrieved October 12, 2007 from http://www.infoplease.com/ipa/A0104575.html

[159] Fraumeni, Barbara M. and Okubo, Sumiye (2004).R&D in U.S. National Accounts. Retrieved October 10. 2007 from http://www.bea.gov/about/pdf/R&D_National_Accounts.pdf

Japan, the portion of publications from Canada 42% in 1991 and 41% in 1999 was in Social Science and Art & Humanities Science. One may argue that only the publications related to the natural science from Japan appeared in the SCI, whereas the publications related to the social science and Art & Humanities science from Canada appeared in higher level contrast to Japan in the citation database.

10.3 Patent Literature in MEDLINE:

Dreck J. de Sola Price (1963) in his famous book "Little science, big science" as showed in the Figure 105, predicted that the scientific journals would be increased exponentially in 100 years.

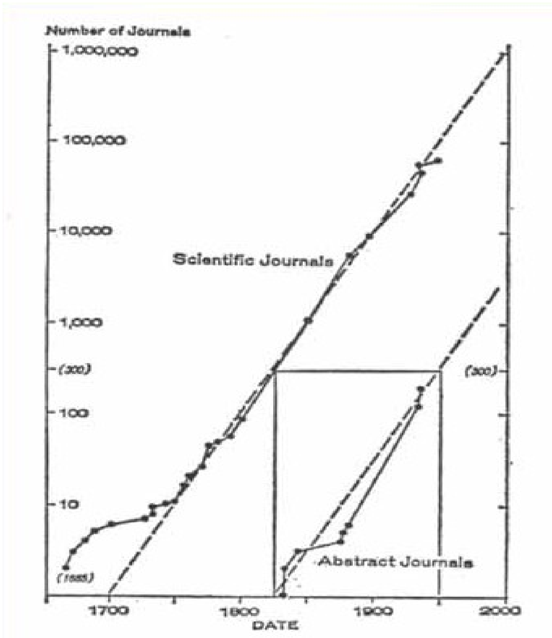


Figure 105: Total number of scientific journals and Abstract Founde, as a Function of date[160]

Umstätter W. (1999) has written: "Die Zahl der angeschlossenen Rechner erhöhte sich von 0.5 Million im Juni 1991 auf etwa 1.3 Million Im Januar 1993 und weiter auf 30 Million im Januar 1996, bei einem erstaunlichen stabilen Wachstum von knapp 10% monatlich. Der Datenverkehr wuchs noch rascher. Von 2 Million Endsystemen, die 1993 über tausende von

[160]Price, Derek J. de Sola (1963). Little science, big science, Columbia university press.

kleinen netzen angeschlossen waren. Befand sich eine halbe Million in Europa und davon 100,000 in Deutschland“[161]

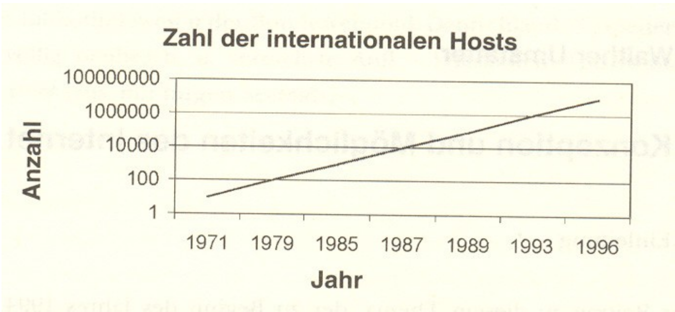


Figure 106: The growing number of international Hosts (Umstätter W. 1999)

In comparison, Figure 107 from the study of Dimec J.[162] (2003) has shown also the rapid growth of Hosts through 1969-2002.

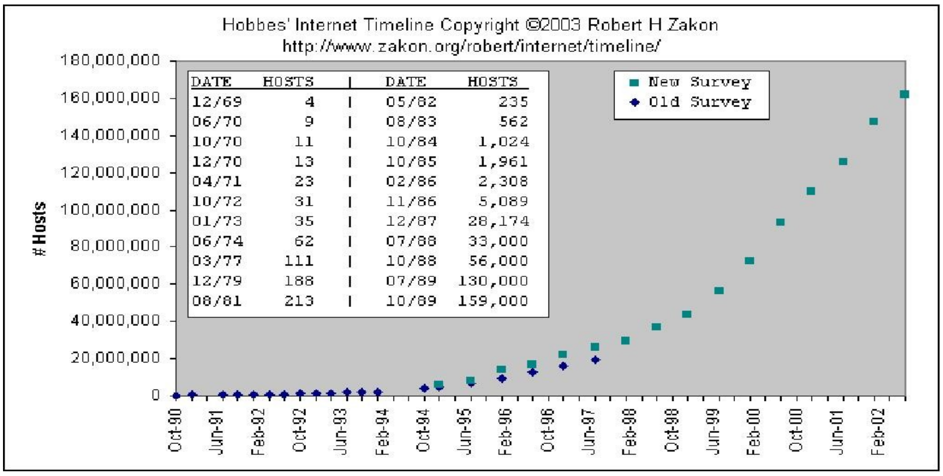


Figure 107: The number of Internet hosts 1969-2002 from the study of Dimec J. (2003).

Following the increasing trend of internet hosts, the number of database has considerably increased (Figure 108).

[161] Umstätter, Walther (1999). Bibliothekswissenschaft in Berlin, Harrassowitz Verlag, Wiesbaden.

[162] Dimec, j. Introduction to medical informatics.Information. Retrieved June 1, 2007 from http://www.mf.uni-lj.si/ibmi/mmedscaa/intro-to-mi.ppt

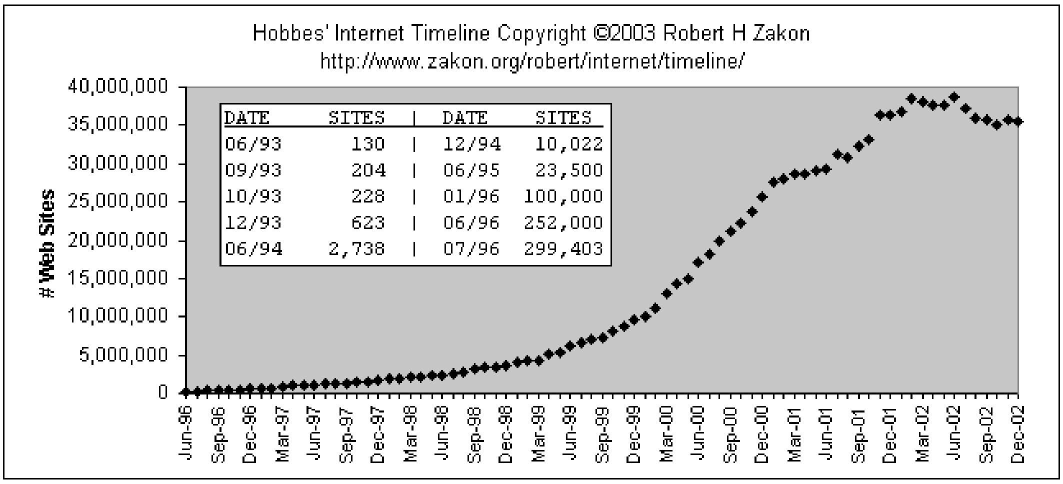


Figure 108: Number of web sites (1993 – 2003) extracted from www.Zakon.org

Following the tremendous growth of Internet hosts, websites, and databases, the scientific activities have increased throughout the world. Accordingly the number of scientific literature in databases such as MEDLINE and SCI has increasingly developed (Figures 28 and 42). The presumption of this increase is clear. Since 1990 the number of Internet hosts, databases, and scientific journals has considerably increased. This facilitated the access of scientist to the scientific information. The international collaboration between scientists developed. On the other hand the number of journals covered by the JCR has linearly increased (Figure 109).

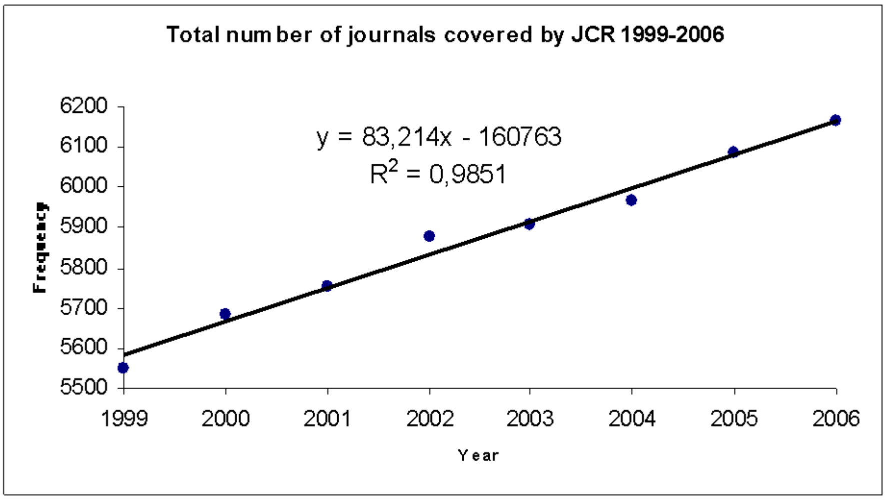


Figure 109: Total number of Journals covered by the JCR 1999-2006

The findings of the study indicated that, after jurisprudence, Genes and DNA- Recombinant were the most frequented Major Mesh main heading in MEDLINE. This validated the study of Waters Baldwin, Lnch Greg, and Scarlett (2001) who has written:

"It is estimated that there are currently more than 36,000 biotechnology patent applications currently awaiting examination at the United States Patent and Trademark Office. Approximately 20,000 of these applications claim DNA fragments or other materials and technologies related to the study of genomics."[163]

10.4 The Trend of languages in MEDLINE:

Science and scientific literature are growing and becoming more and more global and multilingual. While simultaneously the core of scientific publications (in MEDLINE and in SCI) is written more and more often in English.

It is a generally accepted idea that English is the lingua franca of science today. In earlier times, it was Latin or sometimes also French, but now it is without any doubt since the last century English.

If we had a look to the literature of science a hundred year ago, we could find that the languages of scientific literature were few, and consisted of almost 90% of in English, French, and German, Russian and very few other languages.

Currently, we know that the global growth of science literature has brought up in other languages, such as Chinese, Japanese, Persian, Russian, Spanish, Turkish, and many other languages.

Such changes in the world of science would be lead to the transformation of editorial policies for choosing publications to entering the necessary languages data to the databases like MEDLINE, SCI and etc.

On the other hand, the increasing dominance of English on the international relation of scientific collaboration has strongly affected the language of science literature. English is being developed as the main language in the world of science. The reason is clear- a great deal of communication systems are in English. In fact, it should be in English so that international colleagues in the world of science can understand it. The scientists even in non-English speaking countries prefer to publish their works in English. It has some advantages; literature written in English attracts a great number of citations. Colleges distributed all around the world are in better collaboration.

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[163] Waters, Baldwin Sceleston; Lnch, Greg, and Scarlett, Jared (2001). Searching patent databases. Retrieved Jun 1, 2007 from http://www.findlaw.com/12international/countries/nz/articles/568.html

Databases, such as MEDLINE and SCI in the USA, have focused their attention on the literature of science in English. Some previous studies confirmed that the editorial policy for such database in the USA is being changed.

Bedard, M.[164] (2004) analysed 13,865 journal articles on trauma published between 1987 and 2001 indexed in the database of PILOTS (An Electronic Index to the Traumatic Stress Literature). Their study showed that 94% of trauma literature indexed in PILOTS was in English.

Boldt J., Maleck W. and Koetter K.P.[165] (2005) studied the papers published in 10 intensive care medicine journals[166] indexed in the JCR for two periods, 1992 – 1997, and 1998-2003. They took into consideration only the original papers from German universities. They found out that the total number of publications for German universities during 1998-2003 has 100% increased with compare to 1992-1997. The number of publications for German universities increased from 621 during 1992-1997 into 1,245 during 1998-2003.

Loria, A. and Arroyo P[167]. (2005) classified MEDLINE's journal articles by country of publication and language from 1966 to 2000 at five-year intervals. Their study showed that English papers increased linearly and non-English paper decreased at a rate of 1,056 fewer papers annually (table 27). They suggested that the developing trend of English language in MEDLINE was due to the MEDLINE's changing editorial policies that MEDLINE has been increasingly deselecting journals from non-Anglo countries.

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[164] Bedard, Michele; Greif, Jennifer L. and Buckley, Todd C. (2004). International Publication Trends in the Traumatic Stress Literature. Journal of Traumatic Stress, Vol. 17, No. 2, p. 97–101.

[165] Boldt, J. ; Maleck, W. ; and Koetter, K. P. (2005). Wer betreibt intensivmedizinische Forschung in Deutschland?. Dtsch med Wochenschr, Vol. 130, p. 197-202. Retrieved August 1, 2007 from http://www.thieme-connect.com/ejournals/pdf/dmw/doi/10.1055/s-2005-837401.pdf

[166] The journals are: Crit Care Med; Intensive Care Med; Resuscitation; J Crit Care; Crit Care Clin; Circulation; Chest; Am Resp Crit Care Med; Stroke; J Inf Dist.

[167] Loria ,Alvar and Arroyo, Pedro (2005). Language and country preponderance trends in Medline and its causes. Med Libr Assoc. Vol. 93, No.3, p. 381–385.

Table 27: Number and percentage of MEDLINE articles by language and country of publication from the study of Loria, A.

Year	Total MEDLINE journals articles	English	%	Non-English	%	Anglo journals	%
1966	174,400	93,173	53	81,227	47	76,066	44
1970	213,066	125,495	59	87,570	41	98,653	46
1975	234,118	163,388	67	79,730	33	123,573	51
1980	258,329	185,536	72	72,793	28	137,870	53
1985	307,866	233,853	76	74,013	24	168,703	55
1990	367,568	293,265	80	74,303	20	214,027	58
1995	389,170	340,261	87	48,909	13	255,502	66
2000	468,191	419,108	90	49,083	10	317,705	68

Mauricio L. Barreto (2006) analysed the epidemiological articles produced in Brazil that published in the journals indexed in MEDLINE between 1985 and 2004. They found that there was a predominance of the English language among articles by Brazilian authors indexed in the MEDLINE database.

Biglu, M.H. in a study[168] found out that from a total number of 427 journals published in Germany in 2005 and indexed in the JCR, only 11% of them were in German; the rest were in English or in multiple languages. From 146 French journals indexed in the JCR in 2005, 23% were in French, the rest were in English or in multiple languages.

[168] Biglu, Mohammad Hossein (2006). The comparison of impact factor and self-citation trend between French and German journals. Rio de Janeiro, Vol..2, No. 2, p. 143-156.

In another study[169] Biglu, M.H. found that 93.3% of total publications in Tabriz University of Medical Science were published in Persian, and only 6.7% of them were published in English throughout 1988-1996 (Figure 110).

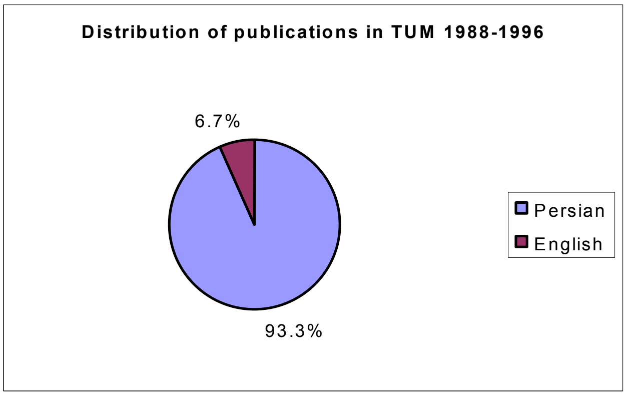

Figure 110: Distribution of publications in Tabriz University of Medical Science 1988-1996

Mélitz, Jacques (2007) in his essay emphasised that English is on its way to becoming the dominant global language. He believes that the global dominance of English is bad news for world literature, because only those written in English will have a chance of reaching a world audience and achieving 'classic status.'

In another study Zhang Haiqi, Shigeaki Yamazaki and Kazuo Urata (2007) found that the percentage of English-language paper in MEDLINE climbed steadily from 75.3% to 86.3% throughout 1984-1994.

Analysis of this study indicated that the portion of publications in English in PubMed increased 44% higher than the total publications in PubMed throughout 1965-2005 (Figure 29). The doubling time of total publications in PubMed through 1965-2005 is 22.5 years whereas the doubling time for publications in English is 15.7 years. In other words, the doubling time of Publications in English is 44% higher than the total Publications in PubMed. The percentage of publication in English has increased steadily through 1965-2005. It reached from 52% in 1965 to 90% in 2005 an increase of 72%. Accurately the Figure may be divided in two stages.

[169] Biglu, Mohammad Hossein (2005). A bibliometric study of scientific out put in Tabriz University of Medical Science. Processing of ISSI 2005, Vol. 2, p.650-651, Stockholm, Sweden, Karolinska University Press.

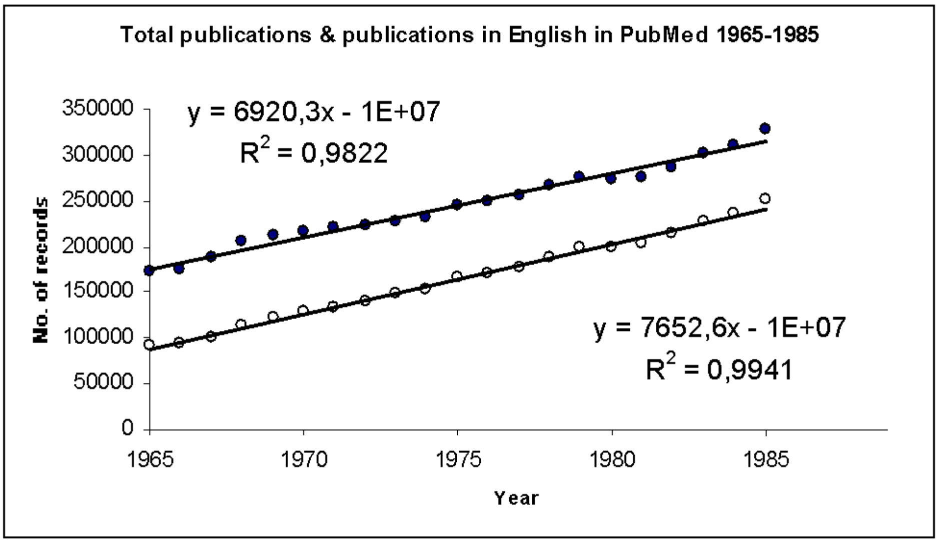

Figure 111: Number of total publications (●) and publications in English (○) in PubMed 1965-1999

As Figure shows the number of total publications (●) and publications in English (○) in PubMed has increased linear through 1965-1985.

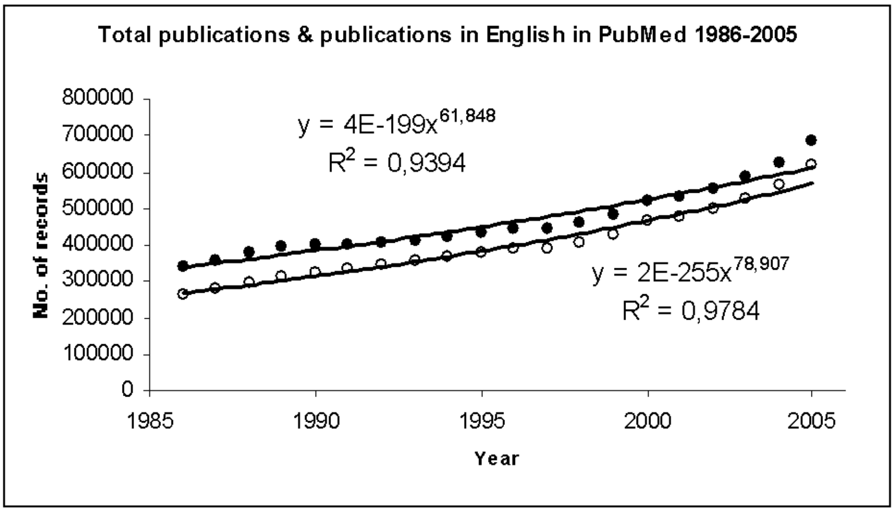

Figure 112: Number of total publications and publications in English in PubMed 1986-2005

Comparison of Figure 111 and 112 indicates that the number of publication in PubMed has increased linear during 1965 and 1985. The number of total publications and publications in English increased exponential through 1986-2005. It indicates that English has increased as main publications language in PubMed. English was the main language of documents indexed in PubMed.

The results of study (Figure 32) are in agreement with the study of Loria, A. and Arroyo (2005). The study expected that the percentage of publication in English in MEDLINE will reach to the saturation level at 97% in 2030, and the percentage of publications in English for Germany and France will reach to the 94% and 88% respectively in 2030.

10.5 The Trend of languages in the SCI:

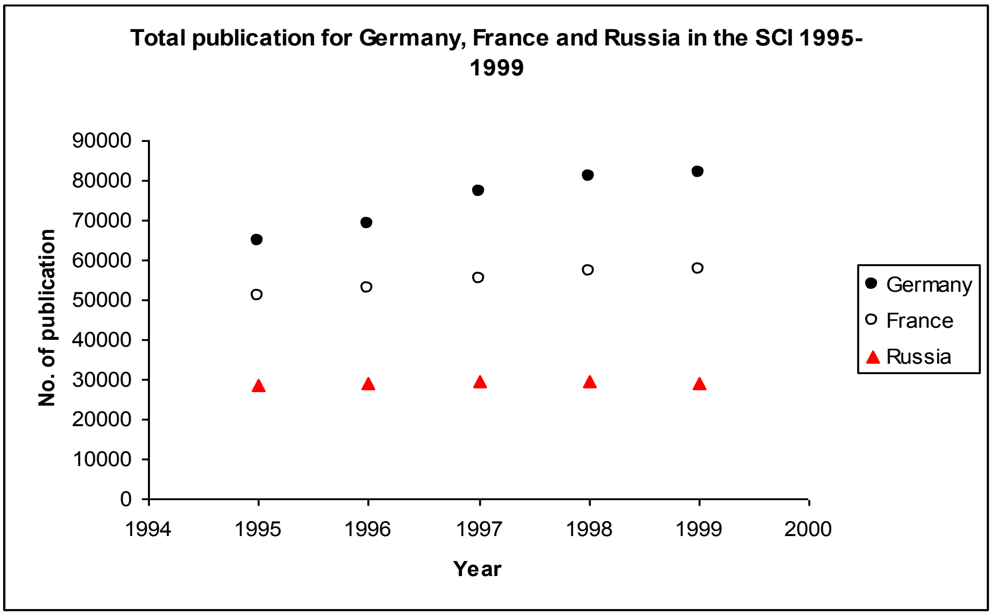

Figure 113: Total number of publication for Germany, France, and Russia in the SCI 1994-1999

Figure 113 shows total number of publications from Germany, France and Russia. It is clear that the growth of publications in Germany indexed in the SCI is higher than the two other countries through 1995-1999.

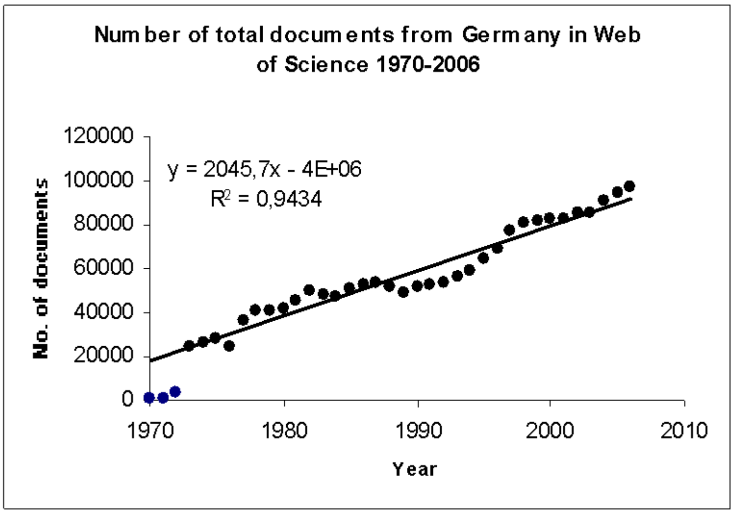

Figure 114: Total number of publication from Germany in the Web of Science 1970-2006

Figure 114 illustrates the total number of publication from Germany indexed in the Web of Science (Science Citation Index expected, Social Science Citation Index, and Art &

Humanities Citation Index) through 1965-2005. As Figure indicates, there was a fall in 1989. Since 1990 there was a boom in the number of publications from Germany in the SCI. most presumably it was due to the communication and collaboration activities among German and American scientists. The step in 1990 for Germany corresponds clearly with the political change, when Mikhail Gorbachev tore down the wall. Thousands of scientists from the former GDR (German Democratic Republic) tried to get in contact with the scientists in the USA and vice versa.

The increase of publications from Germany indexed in the SCI since 1989 was due to the publications in English. On the other hand, the proportion of publication in French from France dropped roughly sharp since 1989, but the proportion of publication in English from France enjoyed relatively sharp growth since 1989 in the SCI. we see the similar trends for other countries such as Italy (Figure 117) too. All these indications evidenced that the policy makers of SCI have focused their attention on the literature of Science in English.

With an accurate look to the Figures 115 and 116 testify that the editorial policy in the SCI has changed and the policy makers in the SCI have focused their attention on the publication in English.

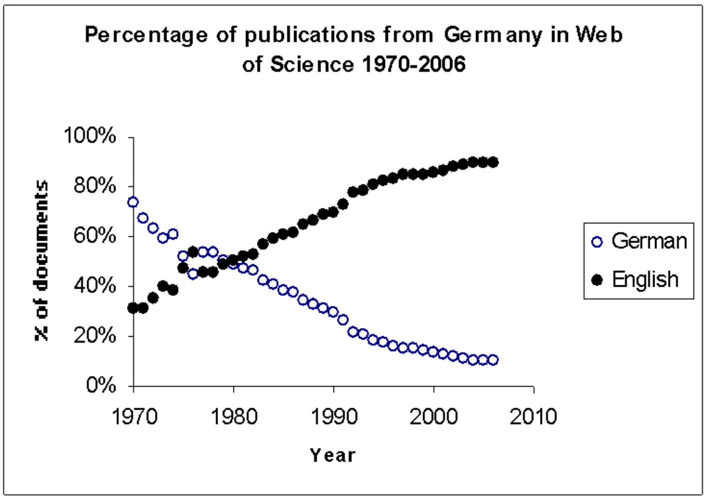

Figure 115: The proportion of publications in English and in German from Germany in the Web of Science through 1970-2005

As Figure 115 illustrates, the proportion of publications in German declined exponential through 1970-2006; whereas the portion of publications in English increased. The portion of publications in English has reached to the saturation level at 89% in 2004.

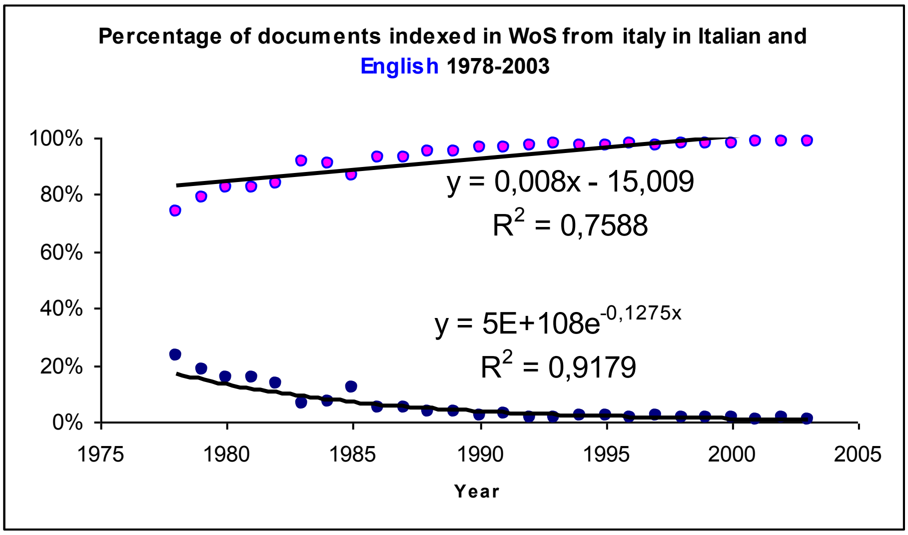

Figure 116: The proportion of documents for Italy indexed in the SCI (WoS) in English (○) and in Italian (●) 1978-2003

The proportion of publications in English from Italy has declined exponential through 1978-2005. The percentage of publications in English from Italy has reached to the saturation level at 99% in 2005.

Tendency towards collaboration with American authors in the SCI in last decades was the another basic cause of increasing the proportion of publications in English in the SCI for countries. Figure 117 shows the proportion of publications in the countries with collaboration American authors in the SCI through 1980-1999.

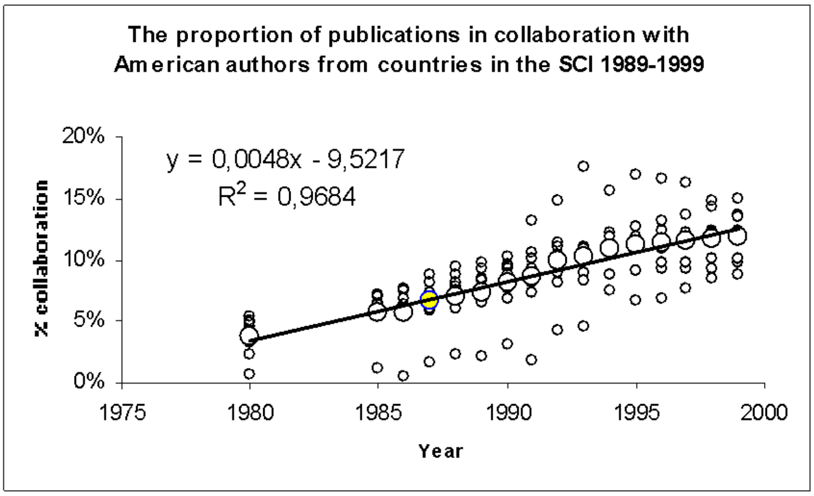

Figure 117: The proportion of publications in collaboration with American authors from countries in the SCI 1989-1999

Figure 117 illustrates the proportion of total scientific publications in 12 countries (Bulgaria, Denmark, England, Finland, France, Germany, Hungary, Italy, Norway, Poland, Romania and Sweden) with collaborate American authors in the SCI through 1980-1999. As shown in the Figure the proportion of collaboration with American authors increased from an average of 4% in 1980 to 12% in 1999. As an average we see a doubling time of 10 years (Figure 118).

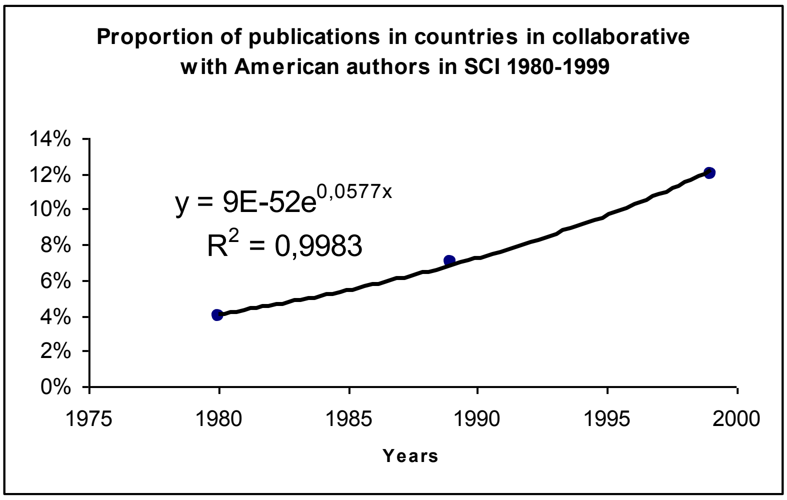

Figure 118: Proportion of publications in 12 countries with collaborative American authors indexed in the SCI 1980-1999

Figure 118 shows that the collaboration of authors from different countries with American authors in the SCI has exponential increased through 1980-1999.

Table 28: Distribution of publications for 27 German professors in German & English

Total publications for 27 German professors	Publications in German	Publications in English	Publications in German featured in the SCI	Publications in English featured in the SCI	Number of citations from the German works	Number of citations from the English works
4,353	2761	1,595	269	1,433	598	21,513

Table 28 maps the total number of publications in English & German for 27 German professors, the frequency of their work that emerged in the SCI and the frequency their work was cited in the SCI.

It is clear that from a total number of 4,353 publications by German professors 2,761 (63%) were published in German and 1,595 (37%) were published in English. The 2,761 publications in German appeared 269 times in the SCI; whereas the 1,596 publications in English appeared 1,433 times in the SCI. The 2,761 publications in German were cited only

598 times in the SCI whereas the 1,595 publications were cited 21,513 times in the SCI. The table indicates that the most majority of works (63%) was in German and only 37% was in English. It is considerable that only 10% of German works was featured in the SCI; whereas the portion of English works was 90%. This is an indication that only the papers in English have high chance to be indexed and cited in the SCI.

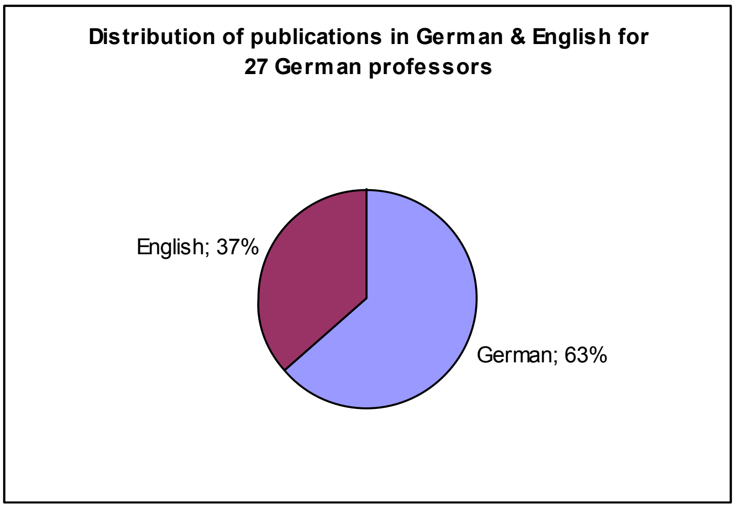

Figure 119: Distribution of publications in German and English for 27 German professors

As Figure 120 shows 63% of German professors´ work was published in German, whereas the publication in English consists of 37%.

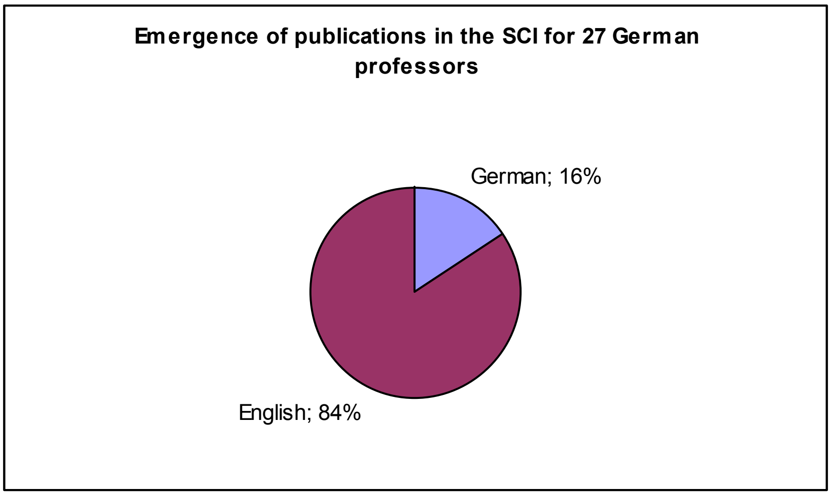

Figure 120: Emergence of publications for 27 German professors in the SCI

As Figure 121 shows 84% of German professors' work that appeared in the SCI was in English, whereas the portion of works in German which appeared in the SCI consisted of only 16% of the total appearance of the work of German professors in the SCI.

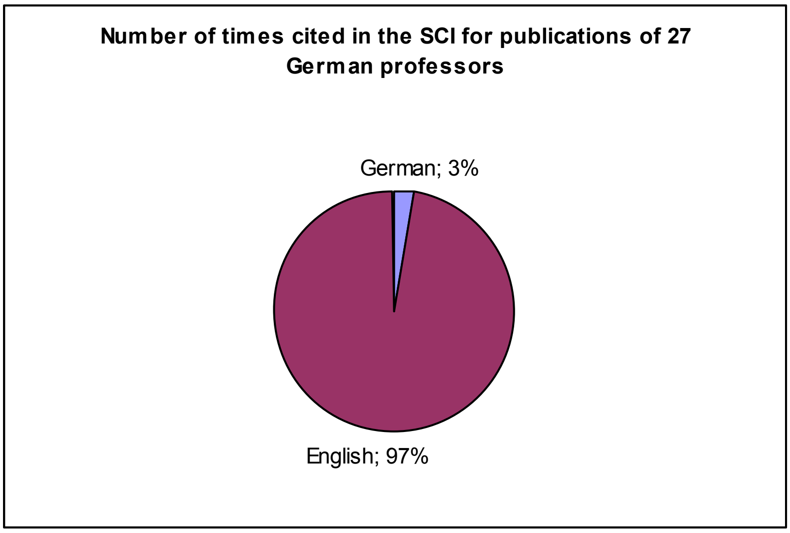

Figure 121: Number of times cited in the SCI for the publications of 27 German professors

As Figure 121 shows 97% of publications for 27 German professors that were cited in the SCI were in English, whereas the portion of work which was in German and was cited in the SCI makes up only 3% of the total cited publications in the SCI.

The comparison of Figures 119, 120 and 121 makes it clear that the publications in English have a higher chance of being featured and cited in the SCI than the German works. This should not come as surprise; because English is the dominant language in the SCI. furthermore the majority of citations to papers in the SCI come from English-Language papers. "…In fact, the majority of citations to papers published in English, German, French, or Italian were from English-language papers…"[170]

[170] Garfield, Eugene (1992). The Languages of Science Revisited: A Focus on Microbiology, 1981-1991. Retrieved August 14, 2007 from http://www.garfield.library.upenn.edu/essays/v15p180y1992-93.pdf

10.6 The trend of languages for publication in the Bielefeld Academic Search Engine (BASE)

The proportion of scientific publications in English is on the decline. The reason is that, every country is producing more or less scientific works, and the great proportion of their works is published in domestic language. This phenomenon leads English to grow as a core language of science while simultaneously the non-English publications spread widely out. This is an effective factor on web pages in the Internet too. "The dominance of English on the internet is declining. Other languages, including lesser-used languages, are now proliferating." [171] Graddol, D. (2006) found that 51.3% of web pages were in English in 2000, and this proportion was 32% in 2005, whereas the proportion of lesser-used languages rose from 11.3% in 2000 to 20% in 2005.

"Geoff Nunberg and Schulze (1998) found that around 85% of web pages were in English. A study by ExciteHome found that had dropped to 72% in 1999; and a survey by the Catalan ISP VilaWeb in 2000 estimated a further drop to 68%. It seems that the proportion of English material on the internet is declining." [172] Although the declaration is not definite enough, nevertheless it indicates that the proportion of web pages in English is declined.

Table 29: The number of publication in English and non-English in the BASE[173]

Year	Total doc	English	Non-English	%English	%non-English
1995	120146	106382	13764	89%	11%
1996	148732	132850	15882	89%	11%
1997	191684	171962	19722	90%	10%
1998	225477	201383	24094	89%	11%
1999	244682	216267	28415	88%	12%
2000	275984	240123	35861	87%	13%
2001	298019	252618	45401	85%	15%
2002	284478	242852	41626	85%	15%
2003	269123	221487	47636	82%	18%
2004	450954	286654	164300	64%	36%
2005	363337	280280	83057	77%	23%
2006	431283	293922	137361	68%	32%
Total	**3,303,899**	**2,646,780**	**657,119**	**80%**	**20%**

[171] Graddol, David (2006). English next. British council. Retrieved October 3, 2007 from http://www.britishcouncil.org/learning-research-english-next.pdf

[172] Ibid

[173] Bielefeld Academic Search Engine. Retrieved October 26, 2007 from http://www.base-search.net/

Table 29 plots the number of publication in English and non-English in the BASE through 1995-2006. It is clear that the most majority of publications (80%) throughout the period of study are in English. Although the great number of publications in BASE is in English, but it is evident that the proportion of publications in English is declined. The doubling time of publications in English is 8.9 years whereas the doubling time of publications in non-English is 3.3 years.

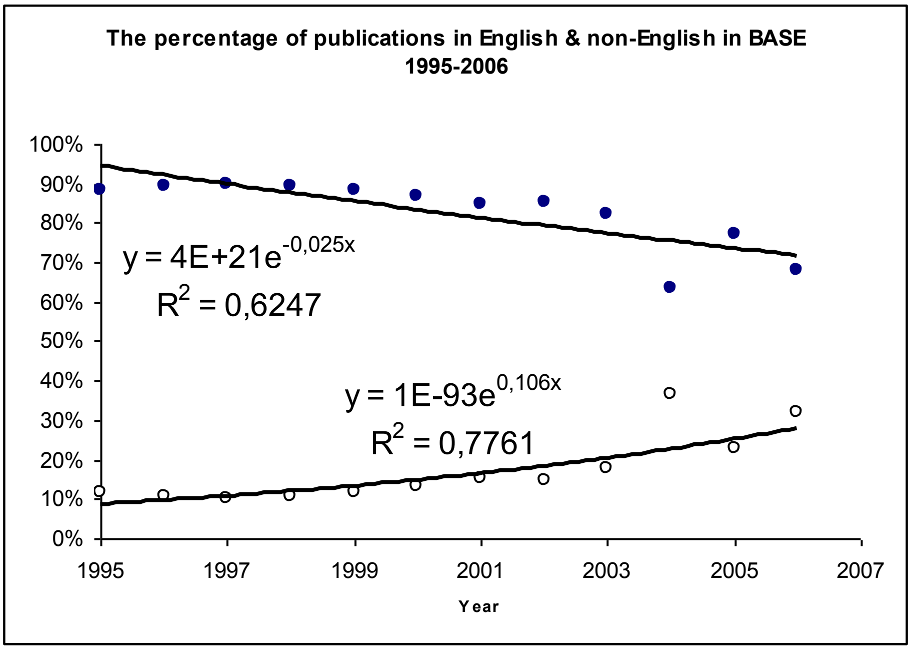

Figure 122: Percentage of publications in English (●) and non-English (○) in the BASE 1995-2006

Figure 122 shows the percentage of publications in English (●) and non-English (○) throughout 1995-2006 in the BASE. Although the percentage of publications in English stays higher then the percentage of publications in non-English, but it is evident that the percentage of scientific publications in English is being declined.

10.7 Cited references per paper, self-citation, and impact factor of journals:

The nearly constant growth of scientific literature with a doubling rate of 20 years since 350 years in the scholarly world led to growing difficulties in libraries to offer all these publications to their patrons. Easier access could be reached in the last years with electronic journals and the digitalisation of books. Such offers in the Internet made it also possible to cite more references in the works. On the other hand attempts to get high prestige among academic scientists and researchers may be one of other reasons that increased the citation rate. Such an elevation of references per paper was registered by E. Garfield in 1980. In his study[174] based on his SCI data base, he showed that the average biochemistry article contained at least 70% more references than the average article in the SCI data base.

Garfield asserted that some CEBJ-journals (Committee of Editors of Biochemical Journals) "have increased their average number of references per source item by as much as 64% in 16 years."

He found "as an average number of references per source item for the core journals for the years 1968 to 1977"

	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
avg. biochemistry	21.2	21.7	21.0	22.3	21.7	22.8	23.9	24.1	23.6	23.4
avg. SCI	12.0	11.6	11.6	12.1	12.4	12.6	13.1	13.3	13.7	13.5

In this comparison biochemistry references were roughly 80% higher than SCI journals.[175]

In this study Garfield raised the question "why should current authors generally cite more references than they did in the past" and his assumptions are that there are five possible reasons.

1. "The first concerns the increase in team research. Since the reward system of science places so much stress on 'first' authorship, this encourages research teams to publish multi-part papers that could just as easily be published as one paper."
2. "A second reason for an increase in the average number of references per paper is the growth of the literature itself. Price argues that part of this increased citation is the inevitable by-product of exponential growth. If the size of the literature that can be cited increases, there is an increase in average citation. This may be true in the early phases of growth, but ultimately there must be a levelling off or all papers will become reviews!"

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[174] Garfield, Eugene (1980). Trends in biochemical literature, Essays of an Information Scientist, Vol. 4, p.419-425. Retrieved December 11, 2006 from http://www.garfield.library.upenn.edu/essays/v4p419y1979-80.pdf.

[175] Garfield, Eugene. (1980). The Number of Biochemical Articles Is Growing, But Why Also the Number of References per Article? Essays of an Information Scientist, Vol. 4, p.414-418. Retrieved October 25, 2006 from http://www.garfield.library.upenn.edu/essays/v4p414y1979-80.pdf.

3. “A third reason may also be related to the SCI and what I call citation consciousness. It comes from the realization that to cite another person’s work is to increase the number of times your own work appears in the Citation Index, which increases the possibility other people will have contact with it.”
4. “A fourth likely reason is the general improvement in the average author’s awareness of newly published material because of improved ‘current awareness’ systems.”
5. “A related fifth possible explanation is that researchers have become more aware of the SCI and other indexing and abstracting tools and thereby have improved their retrospective search capability.”[176]

Especially the last point can be seen today in relation to the pursuit of higher Impact Factors, and a systematic utilization of the Matthew Effect.

The fourth point is not so plausible: If we see the problems of libraries in the last century to make all running journals and other sources available, and the advent of Internet or the Open Access Initiative has not triggered a quantum leap in this development.

The “citation consciousness” of the third point finds its root in the publish-or-perish principle and the discovery, that publications in journals are only high-ranking if the IF is extraordinary.

In Garfield’s first suggestion, most probable the growing number of references per paper is also a consequence of multiple authorships because journal self-citation is growing proportional to the number of references per paper.

As Garfield observed with “more references in biochemistry articles the references are to a higher proportion of older material than was the case previously.” From 1969 to 1977, the percentage of cited papers older than 5 years increased from 46% to 53% for 18 of the biochemical core journals. This would be a hint that the IF’s are influenced only slightly, because the citations are counted from the last two years. (footnote 2)

In his paper from 1980 Garfield has written: “The final aspect of our study was to try to determine which of the core biochemistry journals are most utilized by people in the field. The way we did this was to rank the core journals by their ‘impact factor’. The impact factor of a journal is defined by the average number of citations received per article published during

[176] Ibid

a specific time period."[177] But it has to be mentioned, that the utilization of a journal in contrast to the utilization of the papers in that journal is determined by the number of all publications in that journal and the attraction of references to these publications, but not by the quotient of citations per article during the last years. In contrast, the IF "makes it possible to compare the citation performance of a number of journals which publish different quantities of articles. By comparing the impact we eliminate the advantage a more prolific journal has if absolute citation counts are used. Thus, impact is a qualitative measure."[178]

The study of Fassoulaki A, et al. showed that self-citation of journals is an important factor. "We investigated self-citations in the 1995 and 1996 issues of six anaesthesia journals by calculating the self-citing and self-cited rates for each journal. Self-citing rate relates a journal's self-citations to its total number of references. We defined self-cited rate as the ratio of a journal's self-citations to the number of times it is cited by the six anaesthesia journals. We also correlated self-citing rates with the impact factor of the six journals for 1997. Citations among the six journals differed significantly ($P<0.0001$). Anaesthesiology had the highest self-citing rate (57%). Anaesthesia, Anaesthesia and Analgesia, British Journal of Anaesthesia, Canadian Journal of Anaesthesia and the European Journal of Anaesthesiology had self-citing rates of 28%, 28%, 30%, 11% and 4% respectively. The self-cited rates were 31%, 35%, 34%, 27%, 31% and 17% for Anaesthesia, Anaesthesiology, Anaesthesia and Analgesia, British Journal of Anaesthesia, Canadian Journal of Anaesthesia and the European Journal of Anaesthesiology, respectively. North America journals cited the North America literature. This also occurred, to a lesser extent, in the European anaesthesia journals. A significant correlation between self-citing rates and impact factors was found ($R = 0.899$, $P = 0.015$). A high self-citing rate of a journal may positively affect its impact factor."[179]

In her essay about journal self-citation McVeigh, M.E. has emphasized: "We found that self-citation rate shows only a weak correlation with the impact and subject of a journal. There is

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177 Garfield, Eugene (1979-80). Trends in biochemical literature, Essays of an Information Scientist, Vol. 4, p.419-425. Retrieved November 25, 2006 from http://www.garfield.library.upenn.edu/essays/v4p419y1979-80.pdf.

178 Ibid

179 Fassoulaki, A.; Paraskeva, A.; Papilas K. and Karabinis G.(2000). Self-citations in six anaesthesia journals and their significance in determining the impact factor. Br. J. Anaesth, Vol. 84, No. 2, p.266-269.

also a weak correlation between self-citation rate and the size or specificity of the category (categories) assigned to a journal. Self-citation appears to be a characteristic largely at the level of the individual title, and must be considered only in the context of the title's particular content and history. The removal of self-citations from Impact Factor calculation had little effect on the relative rank of high impact journals. Some journals with lower Impact Factors and rank in category did show more dependence on the contribution of self-citations, but only a small proportion of journals show significant changes in quartile rank following the removal of self-citations. Impact Factor and other performance metrics can provide important information about the role of a journal in the scholarly literature; however, the value and use of these metrics is improved by understanding the underlying data."[180]

It is important to recognize the portion of journal self-citation. In self-citation it should be distinguish between author self-citation, if an author cites his or her previous works, self-citation of different authors in collaborative works, institutional self-citation, self-citation of "invisible colleges"[181] and journal self-citations.

"There are two journal self-citation measures: The self-citation rate, the proportion of a journal's references that are to itself; and the self-citation rate, the percentage of citations recorded by a journal that drive from itself. If journal A contains references to journals A, B and C, journal A is citing A, B and C, whereas journals A, B and C are being cited by A. accordingly, when a journal cites itself, it is both self-citing and self-cited."[182]

With an accurate look at the data extracted from the SCI from 1970 to 2005 in randomised samples of 10,000 records for the number of cited references per documents (table 18) indicates a clear multiplication of references per paper. It shows that the number of cited references per documents in the SCI in 2005 more than 300% increased in compare to 1970. It reached from a mean value of 8.40 references per paper in 1970 to 34.63 in 2005 in the SCI. The reason is clear: the exponential growth of databases, scientific journals, and easy access

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[180] McVeigh, M.E. (2000). Journal self-citation in the Journal Citation Reports – Science edition (2002): A citation study from the Thomson Corporation. The Thomson Corporation. Retrieved November 25, 2006 from http://www.thomsonscientific.com/media/presentrep/essayspdf/selfcitationsinjcr.pdf.

[181] Ron, Bryant.A Short Bibliometric Study: Personal Bibliometric Profile of A.C. De Vries; Critical Analysis and Future Potential. Retrieved November 12, 2006 from http://www.earth.sinica.edu.tw/libhome/e-j/Borgman.pdf

[182] Nisonger, Thomas E.(2000). Use of the Journal Citation reports for Serials management in research Libraries: An Investigation of the Effect of self-citation on journals ranking in library and information science and genetics,College & Research Libraries, Vol. 61, No.3, p. 263-275.

to the scientific information from one side of the world wide communication systems and international collaboration of authors all around the world has led to the increasing trend of references per paper in the SCI.

10.8 Cited-patents in the SCI

Analysis of scientific literature cited by patent documents are known since long time as a method of tracing relationship between science and technology; but tracing the patent documents cited by scientific literature is a modern study of relationship between technology and science. "To our knowledge there has been no attempt to study reverse citation connections. Even specialists in the area of patent citations appear not to have studied this type of citation link."[183]

Wolfgang, Glänzel W. and Meyer M. studied the cited patent documents in the Science Citation Index through 1980.2000. Their study showed that only 1.5% of USPTO patents have been cited in the SCI through 1980-2000. The most patent-citing papers were articles. 92% of papers that have cited patents were articles and notes, followed by reviews (6.8%) and letters (0.8%). The rest (2.2%) were Editorial material and Meeting abstracts. The most majority of cited patent (54.7%) were USPTO patents.

Table 30: The twenty most frequent countries according to the addresses of inventors of patents indexed in the USPTO database from the study of Wolfgang Glänzel W. and Meyer M

No.	Origin of cited-patents	% of cited-patents
1	USA	54.7%
2	JPN	19.8%
3	DEU	7.7%
4	FRA	2.9%
5	UKD	2.8%
6	CAN	2.0%

[183] Glänzel, Wolfgang and Meyer, Martin (2003). Patents cited in the scientific literature: An exploratory study of .reverse. citation relations.Scientometrics, Vol. 58, No. 2, p. 415.428.

7	CHE	1.3%
8	TWN	1.2%
9	ITA	1.2%
10	NLD	0.9%
11	SWE	0.9%
12	KOR	0.9%
13	AUS	0.5%
14	BEL	0.4%
15	AUT	0.4%
16	ISR	0.4%
7	FIN	0.3%
18	DNK	0.2%
19	RUS*	0.2%
20	ESP	0.1%

The study of "International Analysis of Internet-Related Business Methods Patenting" contributed by Mogee Research and Analysis Associates (2001) submitted to the National Science (table 31) showed that 50.3% of cited-patents by other patent were US patents.

Table 31: Priority countries ranked by share of highly-cited patent families for Internet-related business methods: 1995-1999[184]

Priority country	Share of highly cited families	Share of total families	Ratio top highly cited/ to total families

[184]Rausch, Lawrence M. (2003). International Analysis of Internet-Related Business Methods Patenting. Retrived June, 12, 2006. from http://www.nsf.gov/statistics/infbrief/nsf03314/nsf03314.pdf

	Percent		
USA	71.2	50.3	1.4
Japan	6.8	27.1	0.3
Germany	5.5	3.6	1.5
Finland	4.1	0.9	4.4
European Patent Office	2.7	0,9	2,9
Great Britain	2.7	3.0	0.9
Australia	1.4	2.2	0.6
Canada	1.4	1.4	1.0
Denmark	1.4	0.1	11.2
Ireland	1.4	0.4	3.7
Netherlands	1,4	0,9	1,6

Note: In the table above "*Priority country is established by the location of the original patent application. The citations counted are those placed on European Patent Office (EPO) patents by EPO examiners. Highly cited was determined using a distribution definition. Since patenting in this technology area has such a short history, families considered highly cited had one or more citations by later patents. A value of 1.0 indicates that a country's share of the highly cited families is identical to its share of total families, a value greater than 1.0 in the ratio column indicates that a country is overrepresented among highly cited patent families, while a score of less than 1.0 indicates that a country's patent families are underrepresented*."[185]

The result of study showed that 91% of all patent-citing documents in the SCI through 1995-1999 were in the form of articles. Review documents consisted 7% of all documents. The rest

[185] Ibid

(1%) were in the form of Notes and letters (Figure 82). The result of study validated the findings of Wolfgang Glänzel W. and Meyera M.

The study further showed that about half of all cited-patents (47%) by the scientific documents in the SCI through 1994-1999 were the USPTO patents. This is in agreement with the findings of Wolfgang Glänzel W. and Meyer M. further more validated the study of Mogee Research and Analysis Associates which showed that the highly cited patents families for Internet related business were from the USA. The reason is most presumably due to the importance of the USA patents. Tables 3 and 4 indicate that the USA made expensive patents.

11 Conclusion:

The Analyses of data showed that 58% of all patent applications and granted patents issued by USPTO through 1965-2005 belonged to the USA. The portion of the other countries was respectively 42%. Almost all patent applications in the USPTO were granted.

The USA was the leading country applying for patents, and granting patents, followed by Japan, Germany, U.K., France and Canada.

Analyses of data indicated that there is a strong relationship (power law) between the scientific productivity of a country (patent application and scientific publication) and the amount of gross domestic product (GDP) in the country. The relationship between GDP and patent application of the different countries, with applications greater than 500 patents annually, is a linear relationship with a correlation coefficient of $R > 0.96$, in contrast to the relation of patent applications to the population size $R = 0,42$ (power law). This indicates that the money for science is more important than the number of people in insufficiently educated countries. The positive effects of innovation activities may percolate through the economy of countries and the increase income of countries progress the potential for new investments.

This relationship is a valuable exploration; it makes possible to predict one country's patent application quantity or innovation activity, and the amount of scientific output through analysing its GDP and vice versa.

The number of patent applications in the countries had a power law correlation with the number of publications in the SCI. The great number of patent application by a country, the greater the portion of publications in the SCI.

The results of study showed that patent literature in MEDLINE had higher growth than the common growth of the MEDLINE database. It means that patents in medicine have a growing influence. The growth of total documents in PubMed had a doubling time of 22.5 years throughout 1965-2005; whereas the patent literature in MEDLINE had a doubling time of 6.4 years. The annual growth rate of patent literature in PubMed was 11.4% and the annual growth rate of total publications in PubMed was 3.1%.

English was the dominant language of patent literature in MEDLINE, more than 90% of patent literature in MEDLINE was in English followed by Russian (4.12%), French (1.36%); and German (1.20%) whereas 79.49% of total documents indexed in MEDLINE throughout

1965-2005 was in English, 4.11% German , 3.70% Russian and 3.20% was in French. The rest were in other languages.

From a total number of 6,869 Major MeSH Descriptors (Main Headings) in PubMed, after legislation & jurisprudence, Genes with 2.98% and Genetics with 2.39% were the most frequented Major MeSH Descriptors.

From a total of 2,126 authors whose articles indexed as patents with total frequency of 3,122 times in MEDLINE 173 (5.5%) of them were anonymous; 92 (53.18%) of anonymous authors were from the United States and 62 (35.84%) from England. In other words, about 90% of anonymous authors were from the USA and England. The rest 10.98% were from Australia, Canada, Chile, Germany, Ireland, Netherlands, Russia, Spain and Sweden. The origin of one anonymous author stayed unknown.

The USA with publishing 55% of all documents indexed as patents in PubMed was the most prolific country in the term of patent literature, followed by England with 27%, former USSR with 4%, Canada with 2%, Netherlands with 1% and Germany with 1% respectively. It is remarkable that 82% of all publications belonged to the USA and England; only 18% of publications belonged to other countries in the world. The origin country of four documents stayed unknown (in MEDLINE).

Journal "*Nature*" with publishing 14% of all documents, indexed as patents (patent literature) in PubMed was the most prolific periodical, followed by journal "*Science*" with 8%, "*Nature-biotechnology"* with 8%, "*Lancet*" with 2%, "*BMJ*" with 2%, "New Scientist" with 2% and "Food and drug law" with 1% respectively.

From a total number of 31 publications kind regarding to the documents indexed as "patents" in PubMed with a total frequencies of 3,207 titles, 46% of all publications were in the form of journal Articles, 22% in the form of News, 5% Letter, 5% Comment, 4% Review, 3% Editorial, 2% Newspaper Article, 2% Research Support, 2% English Abstract. The rest were less than 2%.

The number of patent literature in the Science Citation Index was two times higher than the number of patent literature in MEDLINE. The growth of patent literature in MEDLINE since 1982 showed higher growth. It indicates that scientists have engaged themselves more with medical fields in the last two decades.

The doubling time of patent literature in the SCI throughout the period of study was 8.8 years, whereas the doubling time of patent literature in MEDLINE was 6.4 years. In other words the doubling time of patent literature in MEDLINE was 41% higher then the doubling time of patent literature in the SCI

From a total number of 7,056 authors with a total frequency of 9,043 times in the SCI, 5.06% of them were anonymous.

From a total of 19 kinds of documents type with a total frequency of 4,808 throughout 1965-2005 related to the documents indexed as patents, Journals article with 58.74% was the most frequented publication type of patent literature in the SCI followed by editorial-materials with 10.50%, reviews with 9.26%, news-item with 5.49%, meeting-abstract with 5.28% and letters with 5.12%.

From a total of 1,448 kind of periodicals with a total frequency of 4,810 times, the journal of "*Expert Opinion on Therapeutic Patents*" with 6.49%, "*Abstracts of Papers of the American Chemical Society*" with 3.80%, "*Nature*" with 3.80%, and "*biotechnology Law Report*" with 2.81% were respectively the most prolific journals in the context of patent literature in the SCI.

English with consisting of 93.88% of all patent literature in the SCI, was the dominant language of patent literature in the SCI, followed by German with 2.56% and French with 1.79%.

The analysis of patent citing and general scientific documents (randomized chosen documents) in the Science Citation Index through 1995-1999 showed that the number of references per paper among patent-citing documents were 18% greater than the number of references per paper for general documents in the SCI. The number of references per paper for patent-citing documents showed a mean value of 34.02, whereas the number of references per paper for general scientific documents (randomly chosen documents) had a mean value of 28.76.

The half-life of citations to the patent-documents was 41% longer than the half-life of citations to the general scientific documents (randomly chosen documents) in the SCI through 1994-1999. This tendency could be due to the importance of patent documents which causes authors to cite them in longer times than the general scientific documents.

The portion of citation classics used as cited references for patent-citing documents was 8 times higher than the citation classics of general scientific documents. The portion of citation classics for patent citing documents was 2% whereas the potion of citation classics for general documents was 0.25%.

Almost half of all cited patents (47%) throughout the period of study were USPTO patents. In other words, the great number of scientists who cited patents; they cited to the USPTO patents. The reason may be is due to the importance of USPTO patents and the dominance of English in the scientific works especial in the SCI

More than 90% of all patent-citing documents (the documents that referred to patents in their references) were published in the form of articles.

The study further showed that, the number of references per paper from 1970 to 2005 has steadily increased. The mean value of references per paper increased from 8.40 in 1970 to 34.63 in 2005, an increase of more than 4 times. Most probably the reason is due to the emergence of online databases, electronic journals, the digitalised books, and open access publications in the Internet that facilitated access to the data sources, information exchange and collaboration among authors more attractively and easier then before. On the other hand attempts to get high prestige among academic scientists and researchers may be one of other reason that increased the citation rate. Such an elevation of references per paper led to the higher IF of journals.

Comparison of journals Impact Factor for 5,499 journals in the JCR in 2002 and the same set of journals in 2004 showed that 75% of journals IF have increased over the span of the years in the same set of journals.

Other finding of study is that, there is a significant correlation between the IF and total citation of journals in the JCR (91% of total citation in 2005 belonged to the 52% of journals with IF> 1, and only 9% of total citation belonged to the 48% of journals with IF<1), and there is an important hidden correlation between IF and the self-citation of journals. The IF of journals has increased parallel by the raise of references per paper and the increase of citations to the same journals through out 1999-2005.

There was a linear correlation between journal self-citing and journal self-cited value, the mean value of self-cited rate always stays higher than the self-citing rate.

The mean value of self-cited rate in 2000 was 14% and the mean value of self-citing rate was 6.61%, whereas the mean value of self-cited rate in 2005 was 12% and the mean value of self-citing rate was 7.81%. As more often a journal was citing other journal as more often it was also cited by a factor of 1.5 (citing/cited) from others. Consequently the growing percentage of journal self citation was followed by journal self citedness.

The study indicated that Science and scientific literature is growing and becoming more and more global and multilingual, simultaneously the core of scientific publications is written more and more often in English, but the percentage of publications in English is on the decline.

There was a tendency in last decades towards collaboration in scientific publishing with American authors that can be observed in the SCI with authors from different countries.

12 Theses:

1. Wissenschaftlichen Publikationen und damit die Wissenschaft selbst wächst bekanntlich seit Jahrhunderten mit einer Verdopplungsrate von etwa 20 Jahren, und breitet sich immer globaler und damit auch mehrsprachiger aus. Gleichzeitig wird der Kern, der im MEDLINE und im SCI erfassten Wissenschaft immer häufiger in Englisch geschrieben, obwohl der Prozentsatz der Publikationen auf Englisch insgesamt sinkt.

2. Es gibt eine Power law Korrelation zwischen der Zahl der Patentanmeldungen (USPTO) in den Ländern und der Zahl der Publikationen im SCI, weil die Zahl der Patentanmeldungen in einem Land seine wissenschaftliche Kapazität untermauert.

3. Das Verhältnis zwischen Patentanmeldungen und Bruttoinlandsprodukt (BIP) der unterschiedlichen Länder (bei Ländern mit mehr als 500 Patenten pro Jahr und Land), ist linear, mit einem Korrelationskoeffizienten von $R > 0,96$, im Gegensatz zu der Relation der Patentanmeldungen zur Bevölkerung, die einem Power Law, mit einem R von nur 0,42 folgt. Das zeigt, dass das Geld für die Wissenschaft viel wichtiger ist, als die Zahl der Bevölkerung die sehr unterschiedlich ausgebildet sein kann.

4. Das Wachstum der in MEDLINE erfassten Patentliteratur ist mit 11,4 % jährlich, 3,6-mal höher als das allgemeine Wachstum der MEDLINE-Datenbank (3,1 %) im Zeitraum 1965-2005. Das bedeutet, dass Patente in der Medizin einen wachsenden Einfluss gewinnen.

5. Die Halbwertszeit der Zitierung von Patenten beträgt seit 1994 konstant 8,1 Jahre. Das ist eine 41% längere Zitierungsrate gegenüber den allgemeinen wissenschaftlichen Dokumenten im SCI, die seit dieser Zeit stetig anwächst und zwischen 1994 und 1999 einen Mittelwert von 5,7 hat. Diese erhöhte Halbwertszeit bei zitierten Patenten entspricht der Studie von Glänzel und Meyer (2003), dass nur 1,5% der USPTO Patente im SCI 1980-2000 zitiert werden, und diese damit nur eine Auswahl der wichtigen Patente darstellen.

6. Es gibt eine lineare Korrelation zwischen der Zahl von Literaturhinweisen (Referenzen) in einem Journal, wie sie im SCI erfasst sind, und der Wahrscheinlichkeit zitiert zu werden. Dieses Verhältnis beträgt 1,5 und besagt, dass auf 2 Referenzen 3 Zitationen des eigenen Journals kommen, von denen etwa 12 % Selbstzitationen sind.

7. Der ungefähr konstante Prozentsatz der Selbstzitationen der Journale bei zunehmender Zahl an Referenzen führt zur absolut wachsenden Zahl der Selbstzitationen und damit zu wachsenden Impact Factors im SCI. Die Zahl von Literaturhinweisen (Referenzen) pro

Dokument im SCI zeigt im Zeitraum von 1970 bis 2005 ein Wachstum von 412%. (von 8,4 auf 34,6)

8. Es gibt im SCI seit 1987 eine deutlich verstärkte Tendenz in Richtung zur Zusammenarbeit bei wissenschaftlichen Veröffentlichungen mit amerikanischen Autoren, die mit Autoren aus vielen unterschiedlichen Ländern kollaborieren. Der Grund liegt einerseits sicher in dem wachsenden Interesse auch unterentwickelter Länder in die vom SCI erfassten Zeitschriften zu gelangen, und andererseits in dem Interesse amerikanischer Autoren dass Wissen aus aller Welt in die angloamerikanischsprachigen Kernzeitschriften zu importieren.

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1. Science and scientific literature are growing and becoming more and more global and multilingual. While simultaneously the core of scientific publications (in MEDLINE and in the SCI) is written more and more often in English, the percentage of publications in English in the world of science is declining.

2. There is a power law correlation between the number of patent applications in the "United State Patent and Trade mark Office" by countries and the number of publications in the SCI. The reason is that the number of patent applications in a country underpins its scientific capacity.

3. The relationship between patent applications and gross domestic product (GDP) of the different countries, with applications greater than 500 patents annually, is a linear relationship with a correlation coefficient of $R > 0.96$, in contrast to the relation of patent applications to the population size $R = 0.42$ (power law). It means that the money for science is more important than the number of people in insufficiently educated countries.

4. The growth of patent literature in MEDLINE with an annual growth of 11.4% is 3.6 times higher than the common growth of the MEDLINE database which sized an annual growth of 3.1% through 1965-2005. It means that patents in Medicine have a growing influence.

5. The half-life of citations to the patents in the SCI is 8.1 years has been constant since 1994. This is 41% higher than the half-life of citations to the general scientific documents in the SCI, which showed an increasing trend with a mean value of 5.73 years through 1994-1999. The reason is that, only very important patents are being cited in the scientific publications.

This is confirmed by a study from Glänzel and Meyer (2003), which has shown that only 1.5% of USPTO patents are cited in the SCI through 1980-2000.

6. There is a linear correlation between the number of references in a journal and the probability to be cited by other journals in the SCI, by a factor of 1.5 [citing/cited]. It means that every 2 references in a journal cause the journal to receive 3 citations.

7. The rough constant percentage of self-citation of journals and the growing increase of total references per paper lead to the increasing number of self-citations and to the increase of the Impact Factor of the citing journals in the SCI. The number of references per paper in the SCI shows a growing of 412% from 1970 to 2005.

8. There is a tendency within the last few decades towards collaboration in scientific publishing with American authors that can be observed in the SCI with authors from different countries.

The reason is that from one side the authors from developing countries want to publish their work in the journals listed in the SCI, and from the other side the American authors desire to import the literature of science in the Anglo-American languages core journal from all around the world.

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Appendix:

Code List for Patents Covered

AP	African Regional Industrial Property Organization
AT	Austria
AU	Australia
BE	Belgium
BG	Bulgaria
BR	Brazil
CA	Canada
CH	Switzerland
CN	China, People's Republic of
CS	Czechoslovakia
CZ	Czech Republic
DD	German Democratic Republic
DE	Germany
DK	Denmark
EE	Estonia
EG	Egypt
EP	EPO (European Patent Organization)
ES	Spain
FI	Finland
FR	France
GB	United Kingdom
GR	Greece
HK	Hong Kong
HR	Croatia
HU	Hungary
IL	Israel
IN	India
IP	Web publication
IT	Italy
JP	Japan
KR	Korea, Republic of
LT	Lithuania
LU	Luxembourg
LV	Latvia
MC	Monaco
MD	Moldova
MX	Mexico
NL	Netherlands
NO	Norway
NZ	New Zealand
PL	Poland
PT	Portugal

RD	Research Disclosure
RO	Romania
RU	Russia
SE	Sweden
SG	Singapore
SI	Slovenia
SK	Slovakia
SU	USSR (Union of Socialist Soviet Repub)
TR	Turkey
TW	Taiwan
US	United States
WO	WIPO (World Intellectual Property Organization)
ZA	South Africa

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Lebenslauf (Curriculum Vitae)

Vorname	Mohammad Hossein
Nachname	Biglu
E-Mail	Mh_biglu@yahoo.com

Universitätsabschlüsse

2003 - 2008	Ph.D. in Bibliotheks- und Informationswissenschaft : Humboldt Universität zu Berlin, Berlin, Deutschland
1993 – 1997	Msc. In Library and Information Science: The University of Tarbiat Modares, Tehran, Iran.
1988 – 1993	Bsc in German & Literature : The University of Shahid Beheshti, Tehran ,Iran
1986-1988	Higher National Diploma. The Paramedical College, Iran University of Medical Sciences, Tehran, Iran.

Berufliche Laufbahn

1999-2003	Dozent und Leiter des Bibliotheks- und Informationswissenschafts-Departments an der Tabriz University of Medical Science.
1997-1999	Leiter des Computer and Informationswissenschafts-Departments an der Tabriz University of Medical Science.
1987-1988	Labor Analyst an dem Universitäts-Krankenhaus. Dies beinhaltete die Analyse der Proben wie Blut, Urin usw.

Eidesstattliche Erklärung

Ich erkläre hiermit an Eides statt, dass die vorliegende Dissertation von mir selbst und ohne unzulässige Hilfe Dritter verfasst wurde, auch in Teilen keine Kopie anderer darstellt und die benutzten Hilfsmittel sowie die Literatur vollständig angegeben sind.

Berlin, November 2007

Mohammad Hossein Biglu

List of Figures

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